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This TOP supersedes TOP 08-2-509 Chemical, Biological, and Radiological (CBR) Contamination Survivability, Large Item Interiors, dated 22 June 2012.

Marginal notations are not used in this revision to identify changes, with respect to the previous issue, due to the extent of the changes.

14. ABSTRACT
This Test Operations Procedure (TOP) provides basic information to facilitate planning, conducting, and reporting of large item interiors testing such as tactical vehicles, fixed and rotor wing tactical aircraft, vans, shelters, building interiors, shipboard interiors, and cargo aircraft interiors. This TOP provides standard methods for chemical, biological, and radiological contamination survivability (CBRCS) testing of interior surfaces of military materiel. It is designed to provide results to determine if large items of mission-essential (ME) equipment have met applicable CBRCS requirements. This TOP describes facilities, equipment, and procedures used to contaminate and decontaminate equipment, sample for contamination density, sample for residual contamination, determine degradation of ME functions resulting from the contamination/decontamination (C/D) procedures, and analyze crew/system under test (SUT) compatibility.

15. SUBJECT TERMS
CBR; chemical; biological; radiological; NBC; nuclear, biological, chemical; contamination; decontamination; survivability; hardness; decontaminability; compatibility; simulant; fallout; material effects, chemical and biological materials effects (CBME) database

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US ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

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DTIC AD No.

CHEMICAL, BIOLOGICAL, AND RADIOLOGICAL CONTAMINATION SURVIVABILITY, LARGE ITEM INTERIORS

*This TOP supersedes TOP 08-2-509 Chemical, Biological, and Radiological (CBR) Contamination Survivability, Large Item Interiors, dated 22 June 2012.

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1. SCOPE.

1.1 Background.

a. The classified Government Accountability Office (GAO) Report, Chemical and Biological Defense: Sustained Leadership Attention Needed to Resolve Operational and System Survivability Concerns, 30 May 2003 (GAO-03-325C[1**]), identified several issues related to the ability of key defense systems to survive after being contaminated by nuclear, biological, and chemical (NBC) agents and subsequent decontamination. In response to that report, a chemical, biological, and radiological (CBR) contamination survivability (CBRCS) implementation plan was developed that was responsive to GAO concerns about the survivability of defense-critical systems and the need for increased management oversight to ensure system survivability. Subsequently, several key elements of that program plan were codified in the Fiscal Year (FY) 2005 National Defense Authorization Act (NDAA), Section 1053, Survivability of Critical Systems Exposed to Chemical or Biological Contamination [Public Law 108-375][2] or chemical and biological contamination survivability (CBCS).

b. Consistent with PL 108-375, on 31 August 2005, the Under Secretary of Defense (Acquisition, Technology, and Logistics) [USD (AT&L)] issued an interim Department of Defense (DOD) policy on CBCS[3].

c. On 9 May 2005, USD (AT&L) issued a memorandum that established final DOD CBCS policy[4]. The final policy replaced the interim policy and included a process for identifying defense-critical systems that needed to be survivable, instructions on how CBCS should be addressed by the military departments, a process for DOD oversight, and definitions of decontamination, hardness, and compatibility.

d. Following the final CBCS policy, details of how a chemical, biological, radiological, and nuclear (CBRN) contamination survivability (CBRNCS) policy is to be implemented were written into the DOD Instruction (DODI) 3150.09[5], which includes specific responsibilities of all organizations impacted by the policy and also expands the survivability requirement to include radiological and nuclear survivability. In addition, a chemical and biological materials effects (CBME) database[6] was developed to address another requirement of Public Law 108-375[2].

** Superscript numbers correspond to Appendix E, References.

1.2 Purpose.

a. The purpose of this Test Operations Procedure (TOP) is to standardize CBRCS testing of the interiors of large items of mission-critical systems to meet thorough decontamination requirements. TOP 08-2-510A[7] separately addresses the exteriors of large items of mission-critical systems. Large items are defined as tactical land vehicles, fixed and rotor-wing tactical aircraft, vans, shelters, building interiors, shipboard interiors, and cargo aircraft interiors.

b. Testing may be performed on full-scale models, scaled models, components, mock-ups, or on representative materials. Testing on the actual items yields more accurate information compared to testing on models, components, or mock-ups. Testing on models, components, or mock-ups reduces realism in testing and the data may require extrapolations in order to compare final information to the full-scale item. If it is not feasible and/or cost effective to use the actual item to determine survivability, then based on coordination between the tester, the customer, and the evaluator, testing alternatives will be considered, and a choice for testing made. The hierarchy or logic for selection of tests (most desirable to least desirable) is:

(1) Full System Interior Testing. Provides full information on the ability of a system to meet the criteria. The use of the actual, full-scale, system under test (SUT) is the most reliable and realistic method for assessing all aspects of the item's survivability. These aspects include assessing for agent trapped in cracks, crevices, between components, in tight places, and in small or odd shapes not easily decontaminable, and evaluating the item's textures and geometry for ease of decontaminability.

(2) Scaled-Down Testing. Uses a smaller version (e.g., one-quarter scale, etc.) in place of the full-size version of the SUT. Evaluation of the test results must take into account the reduced accessibility into small crevices, etc. The test methods described in this document will still be used.

(3) Component Testing. Gives information on the ability of a component or components to meet the criteria. Detailed planning must be conducted to determine if the summation of the data collected from individual component testing can be extrapolated to full system interior testing. If the individual component method is selected for testing to represent the composite large item, the procedures in TOP 08-2-111A[8] will be followed.

(4) Mock-Up Testing. The mock-ups may be specially fabricated to simulate the SUT interior or may be the actual SUT with expensive optical, electronic, or other internal components replaced with appropriate substitutes. Mock-ups must be fabricated of the same materials, have the same coatings, and have similar design features as the intended SUT. The mock-ups must be furnished and/or approved by the materiel developer. The similarities and differences between the mock-up and the SUT it simulates will be carefully documented and analyzed.

(5) A CBR contamination survivability assessment (CBRCSA) is an assessment of the expected ability of the system interior to meet the criteria with the possibility of little or no agent data available for consideration. No actual testing is conducted.

c. CBRCS is the capability of a system and its operators to withstand a CBR-contaminated environment, including decontamination, without losing the ability to accomplish the assigned mission. Characteristics of CBRCS are decontaminability, hardness, and compatibility; these characteristics are defined in Paragraphs 1.4.a through 1.4.c. Agent must be used to measure decontaminability and hardness for the full cycle (contamination, decontamination, and re-issue to the warfighter). Simulants may be used to measure hardness against decontamination methods, solutions, and/or mixtures. CBRCS should be monitored throughout the materiel acquisition cycle and is to be evaluated and assessed during developmental and operational testing.

d. This TOP provides basic information to standardize and facilitate planning, conducting, and reporting CBRCS testing of military materiel and infrastructure interiors. It is designed to provide results to demonstrate that the interiors of large items of mission-critical systems or infrastructures have met the policies of Army Regulation (AR) 70-75[9] as implemented by the Department of the Army (DA)-Approved NBC Contamination Survivability Criteria (NBCCS) for Army Materiel[10], and outlined in the Quadripartite Standardization Agreement (QSTAG) 747, Edition 1[11]. DODI 3150.09[5] outlines CBRNCS requirements for mission-critical systems. This TOP describes typical facilities, equipment, and procedures used to contaminate equipment; sample for contamination density and residual contamination; decontaminate the item; and determine the degradation of selected mission-essential (ME) functions resulting from the contamination/decontamination (C/D) procedures.

e. Neutron-induced gamma activity (NIGA) is not addressed in this TOP. Information on NIGA and initial blast effects can be obtained from other sources [e.g., Field Manual (FM) 3-11.3[12] and Allied Tactical Publication (ATP) 45C[13]].

f. The acronym CBR is used in this document, rather than NBC, to reflect current terminology in use within the DOD. North Atlantic Treaty Organization (NATO) documentation still uses the acronym NBC and this will be reflected in references within this document.

1.3 Limitations.

a. For many systems or infrastructure, the use of actual chemical agents may be limited because of the complexity and cost of testing actual interiors. Where size, complexity, personal safety, or cost prohibits the testing of actual interiors, testing panels and/or components may be required. Therefore, tests on representative panels and/or subcomponents may be conducted. It is imperative that the assigned evaluator be involved early in the test design to confirm that the proposed data collected from these alternative tests are acceptable.

b. When testing is conducted using simulants for chemical agents or agents of biological origin (ABOs) without a corresponding agent/simulant correlation or relationship, the test data must not be used without the establishment of the agent/stimulant relationship. Additional information on the physical parameters that are being simulated must be included in test reports. Overall, it must be noted that simulants do not represent chemical/biological agents in many properties.

c. A simulant will be used to test for radiological contamination survivability. While there is one preferred radiological simulant, it should be noted that there are still limitations associated with using a simulant rather than actual radiological material.

d. The NBCCS criteria[10] and implementation of the procedures of this TOP are not related to the safety criteria of AR 385-10[14], DA Pamphlet (PAM) 385-61[15], DA PAM 385-69[16], or other local regulations governing the safety, handling, storage, and disposition of chemically, biologically, or radiologically contaminated equipment.

e. The procedures for radiological decontamination in this TOP pertain only to removal of simulated radioactive fallout particles or fallout from a radiological dispersal device (RDD). Radiological contamination survivability testing of equipment and systems, as specified in the NBCCS criteria[10], includes NIGA and activity resulting from fallout of radioactive dust and debris. The induced activity creates physical changes to material properties, which remain even after removal of the radioactive dust and debris. Therefore, when determining the radiological contamination survivability of an item, the contributions from both sources must be considered. However, induced radiation cannot be removed or reduced by present CBR-field decontamination materials and procedures, and induced activity hazard testing requires different facilities, instruments, and safety considerations from those described in this document. Survivability from immediate nuclear blast effects and NIGA are not covered in this TOP.

f. This TOP does not, nor does it intend to, identify or predict all scenarios and conditions that may be applicable to CBRCS testing. Therefore, coordination with the combat and material developers and the use of appropriate threat documents is imperative in developing an operationally realistic environment and a comprehensive test. The evaluator will participate in determining the number of test events necessary for each CBRN mission-critical system and ensuring statistical significance. This allows for successful extrapolation and assessment of CBRCS test results for the interiors of CBRN mission-critical systems.

g. Testing of interiors may require a static environment to gain reproducible results, which may not reflect operational scenarios.

h. Measurement of hardness against actual chemical/biological agents is not always possible for system-level interiors. Materials of mission-critical components/systems within the infrastructure that are deemed accessible to chemical/biological agent contamination should be tested at the coupon/representative sample level to assess material changes. The observed material changes would then require an evaluation by the system developer and/or evaluator as to the potential system-level implications. These materials would be tested in accordance with (IAW) TOP 08-2-061A[17].

i. The only criteria for CBRCS as listed in this TOP are for the Department of the Army[10]. Although there is an AR[9] and a DODI[5] covering CBRCS policy, there are no additional criteria from other DOD components. For acquisition programs that have CBRCS requirements, the default is to use the DA criteria[10]. These criteria are not for use in determining decontamination efficacy, but only CBRCS.

j. There are many factors that can affect the performance and/or survivability of a system interior before and after the conduct of decontamination operations. Many of these factors cannot be evaluated for their effects. An example would be the age of the paint on the surface (aged, new, etc.).

k. The compatibility portion of CBRCS will not be addressed in this TOP. Compatibility of operation while wearing personal protective equipment is more efficiently addressed during operational testing.

1.4 General Criteria Evaluation.

The following procedures must be used to quantitatively analyze the ability of an item tested to meet the criteria for decontaminability and hardness.

1.4.1 Determining Decontaminability.

a. Chemical.

(1) Vapor Hazard.

(a) The effective concentration of chemical agent vapor desorbed from the test item over time is C_e with n being the toxic load exponent. The mission time that the warfighter will be near the item is t. Then $C^n_e t$ = dosage, which must be compared with the appropriate criteria[10].

(b) As the SUTs become larger, the ability to collect vapors from the entire system becomes extremely complicated. A sampling method must be developed and validated for collecting vapor samples from interior surfaces. The sampling method must be described in any test report. The sampling method may not provide entire interior surface samples, but may define representative areas to be sampled for extrapolation to the total surface area of the system being tested.

(c) Traditional vapor samplers [bubblers and solid sorbent tubes (SSTs)] will sample vapor streams for discrete periods of time, usually of 2, 4, or 6 hours or longer. The bubbler solvent containing agent or the SSTs with agent residing on the sorbent bed are analyzed and the mass of agent vapors collected is quantified. The volume of agent-laden airstream is determined by using restriction orifices or mass flow controllers to restrict the airflow through the sampler and flow rating the critical orifice on the upwind side before and after the sampling period. The flow rates allow a determination of whether the airflow through the sampler changed over time. The average vapor concentration during the sampling period is calculated by multiplying the mass of chemical agent collected from the sampler times the volume of air that passes through the sampler. The dosage is calculated by multiplying the concentration of the vapors by the time of sampling and the total dose is calculated by adding the dosage ($C^n_e t$) for all sample periods.

(d) The MINICAMS® (OI Analytical, division of OI Corporation, College Station, Texas), is a near real-time analytical instrument that can report vapor concentrations in less than 15 minutes. The air-sampling rate is controlled by an external mass flow controller at 0.5 L/min.

The sampling times (sample, analyze, and then purge) range from 3 to 15 minutes. The total dose is calculated by multiplying each vapor concentration by the total sample time.

(e) A new vapor concentration evaluation method has been developed and is found in TOP 08-2-060[18]. This method uses the vapor concentrations to calculate the toxic load exponent.

(2) Contact Hazard.

(a) The contact mass is measured by analyzing a sampler for the mass of chemical agent that is absorbed from the contaminated surface. The mass of chemical agent per unit area of the sampler must be adjusted to the entire area of the test item that may be contacted by the warfighter.

(b) The mass collected by the contact samplers should be extrapolated from the size of the contact sampler to the average surface area of human contact with the item. An additional factor to consider is the number of "touches" or times that an individual might touch the surface of the object with his hand(s). This value must be compared with the appropriate mass value in Table 1 of the criteria for Army materiel[10].

b. Biological. Colony-forming units (CFUs) are spores that have become viable cells. Decontamination efficacy is determined by forming a ratio of the CFUs sampled after decontamination to the initial number of CFUs when the test item was contaminated with the spores. This ratio is then expressed as the log reduction and is compared with the appropriate criteria[10].

(1) The ratio is calculated as follow:

$$\text{Log Reduction} = \text{Log}_{10}(\text{CFU}_{\text{final}} / \text{CFU}_{\text{initial}})$$

(2) The criteria are based on spore count, which includes both viable and dead spores. Unfortunately, it is impossible to realistically count individual spores. Therefore, a CFU reduction of 6 logs (i.e., reduced by a factor of one million) is used as the pass/fail criteria. If the CFU reduction is greater than 6 logs, then the test item has successfully met the criterion for biological decontaminability.

c. Radiological. Simulants are used for radiological testing. The simulants may include non-radioactive isotopes or short half-life isotopes. The method of evaluation is to use the value of the initial contamination sample and subtract the value of the post-decontamination sample. The resulting difference is divided by the value of the initial contamination sample and multiplied by 100 to determine the decontamination efficacy as a percentage of original contamination.

When using particulate matter as a radiological simulant, this is calculated as follows:

$$\text{Result} = [\ (\text{Initial Number} - \text{Final Number}) / \text{Initial Number}\ ] \times 100\%$$

(1) If the value for decontamination efficacy for short half-life isotopes is less than or equal to the criterion[10], then the item is considered to have successfully met the criterion for radiological decontaminability[10].

(2) The value for decontamination efficacy for non-radioactive isotopes will be compared to the particulate challenge to determine the reduction of particulate matter. This assumes that a reduction of 50 percent of the radioactivity[10] is equivalent to a 50 percent reduction of particulate matter.

1.4.2 Hardness.

CBR hardness[10] is "the capability of materiel to withstand the material-damaging effects of CBR contamination and relevant decontaminations." Changes in critical physical/performance parameters will provide insight as to how the system interior may function following one or more C/D cycles. When the system is tested with a CBR simulant, the only meaningful data will be the hardness of the material/system to the decontaminant.

a. The ME function characteristics will be obtained from the material developer (i.e., voltage output, airflow, pressure, etc.).

b. The ME function characteristics will be initially measured on the test item for baseline functional performance.

c. The C/D cycles will be performed. The same item-specific performance parameters will be measured after each C/D cycle.

d. The post-C/D measurements will be compared to the initial performance measurements to obtain the percent degradation due to each C/D cycle.

e. When requested by the developer, long-term effects (i.e., 30 days or greater), will include additional measurements of the selected functional parameters at scheduled time intervals after completion of the last C/D cycle.

f. Multiple C/D cycles (more than the usual five cycles) should to be considered in situations related to biological contamination not related to biological agents and regular transits from the US to outside the US (usually aircraft). This consideration is intended for military materiel used in a civilian environment.

1.4.3 Compatibility.

The ability to obtain operationally relevant data during development or laboratory testing is extremely limited and may have to be obtained during operational testing. Functions relating to the operation of the SUT are measured while individuals and/or crew members are wearing normal uniforms and while wearing CBRN protective clothing. The percent difference in time to complete a set of tasks with the test item is calculated. If the time is not increased by more than 15 percent[10], the SUT has successfully met the criterion for compatibility.

a. The ME Warfighter tasks, applicable to the system interior, will be obtained from the user for the equipment under evaluation.

b. Timed tasks will be performed in the operator's standard clothing.

c. Timed tasks will be performed in the CBRN protective ensemble.

d. Times and effectiveness of the operator(s) will be compared.

2. FACILITIES AND INSTRUMENTATION.

Facilities, instrumentation, and safety procedures used for CBRCS testing need to be controlled. Additional discussion and requirements for facilities and instrumentation are included in the test procedures (Paragraphs 4.1 through 4.4).

2.1 Facilities.

Item	Requirement
Chemical surety laboratory and chemical agent storage facility.	Constructed to ensure safe and secure storage, handling, analysis, and decontamination of chemical agents.
Chemical agent test facility (chamber).	Constructed to house the SUT during agent or simulant C/D testing and sampling. The chamber must have sufficient volume to allow free air circulation around the SUT. Ability to set and maintain temperature, relative humidity (RH), and wind speed is required.
Fielded decontaminating apparatus as specified in the concept of operations (CONOPS).	Constructed to decontaminate the SUT as part of the test procedure. Must not increase the hazard or degrade safety protocols when used in a laboratory.
Standard decontaminating apparatus.	Constructed to decontaminate the surety test facilities after test completion.
Biological and/or fluorescent particle (FP) analytical laboratories.	Required to store and prepare test quantities of biological and residual radiological contamination simulant materials, to charge disseminating devices, to prepare samplers, and to analyze the biological agent/simulant and radiological simulant FP materials.
Chambers for biological and radiological simulant testing.	The chamber must be equipped with an air intake and an exhaust system, and must have sufficient volume to allow free air circulation around the SUT. Biological surety regulations will be followed if biological surety material is used. Ability to set and maintain temperature and RH is required.

Item	Requirement
Test range or appropriate operational test facility.	Required to allow the SUT to be operated and to perform all ME functions and tasks required to accomplish specific CONOPS as outlined in the capabilities documents. This includes tasks such as communications, aiming and tracking targets, firing weapons, using optical instruments, operating controls and switches, reading instruments, resupply, and decontamination. Observation and measurement of any degradation of the ME functions attributable to the C/D procedures or CBR protective equipment that the test-item operators are required to wear must be recorded.

2.2 Instrumentation.

The instrumentation choices are test and test location dependent. Permissible error-measurement values are minimum requirements. Actual instrumentation may have greater precision. Actual values must be reported in the test report.

Test Parameter	Measuring Device	Permissible Error of Measurement
Air temperature (-20 to 50 °Celsius (°C)).	Thermocouple or similar measuring instrument with digital recording capability.	±0.5 °C).
Relative Humidity (0 to 90 percent).	Hygrometer or similar measuring instrument with digital recording capability.	±2 percent.
Wind speed (0 to 5 meters per second (m/s)).	Anemometer or similar measuring instrument with digital recording capability.	±0.1 m/s.
Photographs.	Still color camera.	Adequate resolution and photographic size to document typical test procedures, details of contamination techniques and contamination density [including mass median diameter (MMD) of drops], and any discrepancies from planned procedures necessitated by operational conditions.

Test Parameter	Measuring Device	Permissible Error of Measurement
Video.	Video camera with time stamp.	Adequate resolution and frames/second speed to document typical test procedures, details of contamination techniques and contamination density (including MMD of drops), and any discrepancies from planned procedures necessitated by operational conditions. Time stamp of video camera must have sufficient resolution to adequately document any timed event being recorded.

2.2.1 Chemical Test Instrumentation.

The instrumentation choices are test and test location dependent. Permissible error measurement values are minimum requirements. Actual instrumentation may have greater precision. Actual values must be reported in the test report.

Test Parameter	Measuring Device	Permissible Error of Measurement
Contamination density or challenge level (g/m^2) and drop size in millimeters (mm).	Digital imaging device for digitally measuring the diameter of the drops. Software for calculations. A control coupon will also be used for the measurement of the actual contamination density applied. Printflex cards, filter papers, photo paper, or equivalent.	Contamination density, ± 10 percent of challenge target. Drop size diameter, ± 10 percent.
Chemical agent mass from liquid samples (microgram ((µg)).	Gas chromatograph (GC), high-performance liquid chromatograph (HPLC), liquid chromatograph (LC), spectrophotometer, or equivalent.	±15 percent of calibration standard.
Chemical agent mass from vapor samples (µg).	MINICAMS®, GC, HPLC, LC, spectrophotometer, or equivalent.	±15 percent of calibration standard.

2.2.2 Biological Test Instrumentation.

The instrumentation choices are test and test location dependent. These values are minimum requirements. Actual instrumentation may have greater precision. Actual values must be reported in the test report.

Test Parameter	Measuring Device	Permissible Error of Measurement
Contamination measurement (background, post-contamination, and post-decontamination).	Microscopes, swabs or wipes placed in growth medium, automatic colony counters, or equivalent.	±10 percent CFU/sample.

2.2.3 Radiological (Simulant) Test Instrumentation.

The instrumentation choices are test and test location dependent. Permissible error measurement values are minimum requirements. Actual instrumentation may have greater precision. Actual values must be reported in the test report.

Test Parameter	Measuring Device	Permissible Error of Measurement
Contamination measurement (background, post-contamination, and post-decontamination).	Non-isotope challenge: Microscopes or equivalent.	±5 percent particles/m^2
	Isotope (non-radioactive or short half-life) challenge: GC/mass spectrometer (MS), radiation detector, or equivalent.	To be determined based upon instrument used.

2.2.4 CBR Hardness Test Instrumentation.

Test Parameter	Measuring Device	Permissible Error of Measurement
ME functions as described in specific CONOPS.	As necessary (optical haze, transmittance, durometer, tensile strength, etc.).	Precision and accuracy requirements must be compatible with the nature of the SUT and type of function but must allow for the detection of 20 percent degradation in the ME performance characteristic after completion of each of the required C/D cycles.

2.2.5 CBR Compatibility Test Instrumentation.

Test Parameter	Measuring Device	Permissible Error of Measurement
Operator performance.	Stop watches or equivalent. Operator/crew ME functions (e.g., operating a computer, conducting maintenance operations, etc.) are timed and/or accuracy-based functions. The standards for ME functions are outlined in system-specific doctrinal and training publications or are established by the combat developer for that system. The difference between the function performed with duty uniform and with CBRN-protective clothing allows a determination of the percent degradation of the task.	Precision and accuracy requirements must be compatible with the nature of the test item and type of function being studied, but must allow for the detection of 15 percent degradation in the item/operator ME function performance.

3. REQUIRED TEST CONDITIONS.

a. CBRCS testing requires the handling and use of chemical and biological agents. Hazardous radiological materials may also be required. Such testing is strictly controlled by U.S. Army regulations (e.g., AR 385-10[14] for general safety, DA PAM 385-61[15] for work with chemical agents, and DA PAM 385-69[16] for work with biological materials). Throughout testing, primary emphasis must be on operator and equipment safety. The importance of technical quality, completeness of test data, and conformance with specified test and operating procedures must be emphasized.

b. The required test parameters[10] are temperature (30±3.0 °C) and airflow across the SUT of less than 1.0 m/s. There is no requirement for RH.

3.1 Test Planning.

a. Each CBRCS test plan must be reviewed for technical accuracy, conformance to regulations. Standing operating procedures (SOPs) applicable to the specific item and tests being conducted must also be reviewed. In addition, the test plan must accurately reflect the requirements outlined in capabilities documents. Published test records, procedures, and the case files of tests of similar items to identify potential areas that may be difficult to decontaminate must be reviewed.

b. The capabilities documents [initial capability document (ICD), capability development document (CDD), or the capability production document (CPD)], the CONOPS, and failure definition/scoring criteria (FD/SC) must be reviewed. The operational test agency (OTA) evaluation plan (OEP) and the test and evaluation master plan (TEMP) will be used to determine the overall test structure, data required, criteria, and analysis to be used. The ME function performance characteristics specified by the materiel developer and the combat developer will be

listed. These will be used to measure the degradation in performance caused by CBR C/D. Units of measurement and the accuracy and precision required for each parameter measured will be identified. All issues concerning measurable performance and degradation will be reviewed.

c. Based on the information collected from the capabilities documents, the OEP, and the TEMP, and in coordination with the customer, the number of SUTs and the number of C/D cycles that need to be conducted on the SUT will be determined. The NATO QSTAG[11] dictates that a default of five C/D cycles should be conducted on each SUT to accommodate one radiological cycle, one biological cycle, and three chemical agent cycles for the three classes of chemical agents. Because there are no radiological procedures in this TOP, additional biological or chemical cycles may be substituted. It is possible that less than or more than five cycles may be required.

d. A realistic test-item sample size (based on test cost, as well as test-item size, value. And availability of the SUT) will be determined through review and coordination with the assigned operational test activity evaluator. The sample size may be determined by test item availability, cost, or other factors that may cause it to be less than optimum. If sample size is less than optimum, a testing scheme will be devised to optimize test item use and required data output. The use of the design-of-experiment will be considered in developing the test matrix.

e. Representative areas of the SUT or infrastructure interior under test to be sampled for residual contamination will be selected and identified. The number, location, and shape of the areas selected to be tested will depend on consideration of test item size, geometry, materials of construction, surface texture, presence of joints and crevices, areas handled/touched by system operators, and the likelihood to contribute to producing a vapor or contact hazard. Because of the nature of contact sampling devices, sample locations need to be flat or nearly flat. Coupons of the same material as the sample location (including any paint, anodizing, etc.) can be used by attaching the coupons on the sample location and removing them for liquid extraction of residual contaminant. Additional consideration must be given to any areas that might allow contaminating agents and/or simulants and decontaminating solutions to seep into and degrade delicate or vulnerable equipment. An appropriate number of such areas will be selected to help assure the statistical validity of the resulting number of samples. The test plan will identify and explain the rationale for the areas selected and the statistical analysis methodology used. The test report will identify any changes from the test plan. Each sample location selected must be described and photographed. No additional marks should be placed within the marked boundaries of the locations to be sampled.

f. C/D cycles will be conducted using CBR agents and/or simulants and fielded decontamination systems and procedures. Actual survivability can only be confirmed by using actual agents. The default chemical agents[10] are persistent nerve agent (VX), distilled mustard (HD), and thickened soman (TGD). A biological simulant may be used in place of an ABO.

g. Decontamination systems and decontaminants include, but are not limited to: the M291 skin decontamination kit; the M295 individual equipment decontamination kit; the M100 sorbent decontamination system; the M12; the M17; hot soapy water (HSW); and supertropical bleach (STB). Field expedient decontaminants include, but are not limited to: high-test hypochlorite (HTH); household bleach solutions (usually a ratio of one part bleach to ten parts water for

biological decontamination); alcohol-wetted cloth (for sensitive or electronic equipment); and low-pressure, high-volume water.

h. If the system consists of materials similar to other systems already tested [i.e., both system's chassis are chemical agent-resistant coating (CARC)-painted steel, or both systems are bulldozers with one being larger than the other], then consideration may be given to conducting a CBRCSA as a cost-saving measure. Before implementing this option, coordination must occur with the test sponsor and the OTA conducting the system evaluation. The basic steps of a CBRCSA are:

(1) The test-item design and the materials of construction will be examined. The materials of construction will be reviewed to see if any data pertaining to those materials can be found in the CBME database[6]. An analysis will be performed based on previous test experience and technical information concerning the material's ability to survive exposure to contamination, decontaminants, and the decontamination process. If there are material effects data in the CBME, then the data can be reviewed for applicability to the current system.

(2) Any areas where CBR agent could pool or seep, such as cracks, crevices, hinges, joints, countersunk screw heads, or other difficult to decontaminate features, will be noted. The manufacturer's operation manual or preliminary instructions, if available, will be reviewed for any cleaning/decontamination instructions.

(3) The CBRCSA will recommend that any identifiable vulnerabilities or questionable design or materials should be adequately tested. If the assessment in Paragraph 3.1.h(2) reveal any aspect of design or identify a material that appears to make test failure probable, testing of the suspect design or material should be performed early in the test cycle.

(4) Preliminary results can often be determined from a pilot study and analysis of the collected information. The report of the survivability assessment will detail the expected ability of the system to meet the CBRCS criteria[10].

i. Qualified and trained operators and standard equipment (decontamination, maintenance, and calibration, etc. that warfighters would use with the system) may be scheduled for tests involving the use of simulants. Standard decontamination procedures will be developed for the SUT, if required. Before testing begins, rehearsals must be held to familiarize the test team with the functioning of the SUT, test procedures, and data requirements. The team must practice using simulants until CBR agent-dispensing, decontamination, and sampling become reproducible and routine. The SUTs used during the actual test must not be used for rehearsals with simulants unless it is the only SUT available and testing will be conducted outdoors. It is recommended that one or more dry-runs be performed to give operators an opportunity to demonstrate, standardize, and become proficient with operational procedures.

j. For tests involving different threat agents than described above, the appropriate laboratory will be scheduled to conduct the test, and laboratory technicians will receive appropriate system-operating training before testing begins.

3.2 Environmental Documentation.

All local, state, and federal regulations will be complied, appropriate documentation prepared and submitted, and approval received before testing begins.

3.3 Safety.

a. Applicable safety and surety regulations will be reviewed to ensure all test procedures are in compliance.

b. Every effort should be made when planning and designing the test to ensure safety to personnel who will be handling and working with chemical, biological, or radiological materials.

3.4 Quality Assurance (QA).

a. Controls and limitations applicable to a specific subtest are presented in Paragraph 4 as part of the procedure to which they apply.

b. A QA plan must be prepared for each test program to ensure that all variables that can be controlled are controlled and that appropriate records are kept throughout the duration of testing. Variables that cannot be controlled must be identified in the test plan. Test variables include but are not limited to: purity and stability of CBR agents and simulants used, purity and stability of decontaminants, calibration and maintenance of instrumentation and disseminators, accuracy and precision of the laboratory instruments, and quality and uniformity of all test samples.

c. The condition of the SUT at the time of testing is an important test variable. Unless receipt inspection was accomplished as part of a subtest completed before CBRCS testing, the SUT should be inspected IAW TOP 08-2-500[19]. Inspection data, certificates of compliance, or similar documentation must be reviewed to ensure the interior surfaces, finishes, and packaging meet specifications. Generally, the item must be tested in as-received condition, matching its condition when issued to warfighters in the theater of operations as closely as possible. CBRCS testing may be required periodically throughout the equipment life cycle if the effect of normal wear is a major factor in survivability.

d. Decontamination. Existing system-specific decontamination procedures, using fielded decontaminants or developmental decontaminants, must be reviewed and incorporated into the planned test as much as possible. Any deviations from existing procedures in the test plan must be documented in the test report.

e. Test Conduct. Testing must always be conducted following approved test documentation, such as technical manuals, FMs, equipment operating instructions, SOPs, this TOP, the approved test-planning directive, OEP, TEMP, and the test plan. Deviations from test documentation will be put in writing and approved by the appropriate authority as part of the test plan and report.

4. TEST PROCEDURES.

Paragraphs 4.1 through 4.3 address CBR contamination survivability testing separately. Although the test methods are similar, subtle but important differences exist. Long-term CBR hardness is discussed in Paragraph 4.4.

4.1 Chemical Agent Contamination Survivability Testing.

4.1.1 Objectives.

a. Decontaminability. The ability of a system or infrastructure to be rapidly and effectively decontaminated (less than 75 minutes)[10] following chemical-agent exposure will be determined. Vapor and contact hazards, including eye effects (miosis), associated with warfighter use of equipment that has been contaminated with chemical agent and decontaminated using standard and/or item-specific decontamination procedures will be determined.

b. Hardness. The capability of a system or infrastructure interior to withstand the material damaging effects of chemical agent and relevant decontaminants. Measure the degree of performance degradation in ME functions of military mission-critical materiel after each C/D cycle by standard and/or item-specific procedures.

4.1.2 Criteria and Conditions.

4.1.2.1 Criteria.

a. Decontaminability. The interior surfaces of systems developed to perform ME functions shall be designed so that chemical contamination remaining on, or desorbed from, the surface following decontamination shall not result in more than a negligible risk (5 percent mild incapacitation) to unprotected military individuals working inside, on, or 1 m from the system after chemical agent C/D, as stated in the criteria[10].

b. Hardness. Mission-critical systems shall be hardened to ensure that exposure to the specified C/D cycles does not degrade the operational ME functions of the system more than 20 percent (or that specified by the combat developer) over a 30-day period[10] or as defined by the capabilities documents.

NOTE: As an example, if the hydraulics of a cargo aircraft loading ramp are consistently able to lift the ramp in 10 minutes before decontamination and can only lift the ramp in 15 minutes after five cycles of decontamination, then the degradation is measured as [(15-10)/10]×100 = 50 percent.

4.1.2.2 Conditions.

General conditions are as follows:

a. Selected interior areas will be initially contaminated in a random drop pattern (if a syringe or pipettor is used) or by an aerosol generated over the selected surface, to a uniform contamination density as specified in the system threat assessment and capability documents. If

no operationally relevant drop size has been determined, the default size will be 5 to 10 microliter (µL) sized drops of TGD, or 2 to 5 µL sized drops of unthickened HD or VX. If the system threat assessment does not specify contamination density, 10 percent of exterior contamination or 1 g/m² (IAW the NBC criteria[10] and the QSTAG 747[11]) will be used.

b. The purity of the chemical agent and/or simulant used must be known (preferably 85% or greater) and recorded as test data. A purity certification must be provided with the chemical agent used for testing. The quantity applied may be adjusted to achieve the required pure agent contamination density. If weapons grade agent is used, the purity must be measured and recorded as test data. If simulant testing is necessary, a simulant/agent correlation must be fully documented IAW the provisions of Paragraph 4.1.6.

c. The amount of time between contamination and the start of decontamination operations (often called weathering or aging time) will depend on requirements in the capability documents. The default weathering time is 60 minutes[10]. Given changes in battlefield doctrine, the default weathering time may not be representative of the actual travel time from a contamination site to a decontamination site. Weathering time must be coordinated with the test sponsors and combat developers. Standard field and/or item-specific decontaminants, equipment, and procedures will be used as much as possible. The decontamination procedure conducted and time between C/D cycles will be included in the test plan for each system or equipment item. The decontamination process time (excluding point detector monitoring) must be recorded.

d. The interior surface temperature will be 30° C. Because air movement patterns are generally stagnant for interiors, there is no criteria for wind speed.

4.1.3 Controls and Limitations.

The controls and limitations for chemical agent/simulant contamination survivability testing are:

a. Testing may be performed with simulants on system-level interiors, or chemical agents testing may be performed on representative panels, components, mock-ups, or scale models.

(1) Surface areas selected for sampling must be representative of the interior surface materials, texture, paint, and areas where the user will have direct contact.

(2) Before each trial, the interior surfaces will be inspected and sampled (vapor and contact) for background contamination. All residual background decontaminant and other foreign substances that could interfere with sample analysis or with analytical instrumentation must be removed before trials are conducted.

b. Analysis control data include standard analytical controls (see Paragraph 4.1.5.6). The standards need not be at equal concentration intervals; rather, they should be spaced closer together near the low-concentration end of the calibration curve.

c. Test controls should include:

(1) Vapor only. When using a SST, bubbler, or similar vapor sampler, a non-operated sampler control (a sampler taken into the area surrounding the SUT but not used, opened, or aspirated).

(2) Vapor only. Operated sampler control (a sampler taken into the area surrounding the SUT and used, opened, or aspirated, but not exposed to chemical agent or simulant).

(3) Positive control, which is a SUT or panel that is contaminated but not decontaminated.

(4) Negative control, which is a SUT or panel that is not contaminated but is decontaminated.

d. Instrumentation calibration will be recorded as part of the test record and will include the calibration requirement (yearly, semi-annual, etc.).

e. Threat agent tests will be conducted inside a surety test facility approved for use with the particular threat agent.

4.1.4 Data Required.

The following data in the units indicated will be reported:

a. Test Chamber or Interior Space:

(1) Temperature in °C.

(2) RH in percent (especially if the decontaminant requires a specific relative humidity).

(3) Wind speed (airflow) in m/s (of test chamber when doing component testing).

b. Chemical Agent or Simulant:

(1) Name and control number.

(2) Purity in percent.

(3) Name, product identity, and manufacturer of thickener, if thickened.

(4) Quantity of thickener in grams per liter (g/L), if thickened.

(5) Viscosity after adding thickener in centistokes (cSt), if thickened.

(6) Age since thickening, if thickened.

(7) Name, product identity, and manufacturer of dye, if used.

(8) Quantity of dye in g/L, if used.

(9) Quantity of chemical agent/simulant dispensed in g.

(10) Chemical agent/simulant contamination density in g/m^2.

(11) Chemical agent/simulant drop volume in µL.

c. Results of each post-decontamination agent/simulant vapor (collected during the sampling period) and contact sample and contact sample in µg/sample.

d. Complete description of the contact sampler used (material type, lot number, diameter, thickness, and any other pertinent information). Description of any contact sampler efficacy and/or solvent extraction efficacy studies conducted on the contact sampler and solvent used for extraction.

e. Total number and location of contact samplers.

f. A description of the required contact-sampling times specified.

g. Results of sampling and analysis controls and standards in µg/sample.

h. Sample history with elapsed time to analysis in days.

i. Contamination, weathering, decontamination, and sampling elapsed times in minutes.

j. Description of decontamination solutions (i.e., formulation, active ingredients, lot number, and age).

k. Description of decontamination methods, equipment, and system-specific procedures used during decontamination.

l. Description and photographs of the system interior surface condition (pretest), including construction materials, paint type, paint thickness (number of coats), paint condition, and surface cleanliness (e.g., mud, grease, etc.).

m. Pretest (baseline) and posttest (30 days after the first contamination and/or other defined long-term time interval) ME functional performance data, recorded to the highest level of accuracy and precision that is commensurate with the parameter being measured.

n. Description and photographs of system joints, cracks, crevices, and other features that could allow contaminants or decontaminants to penetrate the surface and may be difficult to decontaminate.

o. The stain size, on the surface if any, caused by the agent drops (if safety procedures permit and if this information is desired).

p. Description and photographs of any materials degradation (e.g., corrosion).

q. Identification of the C/D cycle event.

r. Any relevant safety findings as a result of testing.

4.1.5 Methods and Procedures.

4.1.5.1 Test Method Outline.

a. Receipt inspection will be conducted on the SUT to document as-tested material conditions. Receipt inspection may include functional performance tests to establish baseline performance parameters (e.g., computer is operational, aircraft avionics are operational, etc.). Paragraph 4.1.5.7 describes the details for this step of the test method.

b. The Chemical agents/simulants will be prepared for application as described in Paragraph 4.1.5.8.

c. SUT will be prepared for testing, to include sample location, identification and documentation; marking of sample areas; etc. Paragraph 4.1.5.9 describes the details of this step.

d. Test chamber operation will be verified and environmental conditions for the test stabilized. If an item is too large to fit properly in a chamber, testing may be conducted outdoors with appropriate simulants. Environmental conditions will be monitored, the SUT will be allowed to equilibrate with the ambient conditions, and any required background samples will be taken before contamination IAW Paragraph 4.1.5.10.

e. Chemical agents/simulants are applied to the SUT. Paragraph 4.1.5.11 describes the details of this step.

f. Decontamination operations will be conducted on the SUT as described in Paragraph 4.1.5.12.

g. Post-decontamination vapor and liquid (contact) sampling and sample analysis will be conducted as described in Paragraph 4.1.5.13.

h. Sample analysis will be performed as described in Paragraph 4.1.5.13.

i. Hardness determination, including post-decontamination functional performance measurements, will be performed IAW Paragraph 4.1.5.14.

j. Data presentation procedures are in Paragraph 6.2.

4.1.5.2 Significance and Use.

a. The sample data collected from CBR contamination survivability testing allow a determination of contact and vapor hazards to unprotected military personnel from decontaminated military materiel.

b. The functional performance and/or material effects data collected allow a determination of the amount of physical or functional degradation of the system resulting from chemical/biological (CB) C/D procedures and materials to determine if there is a hardness issue.

c. Exact repeatability is lost with outdoor testing because of the variable and uncontrollable natural environmental conditions, such as wind speed, sun exposure, etc.

4.1.5.3 Interferences.

a. There are no interferences when the test method is conducted under laboratory-controlled conditions.

b. Outdoor testing has inherently uncontrolled or extreme variances in temperature, humidity, and wind speed. The extreme variances are constituents or properties that will create test conduct interferences.

4.1.5.4 Apparatus.

a. The term apparatus will be used to cover the test fixture in which a test may be conducted as well as the equipment used in conducting testing, sampling, and analytical instrumentation.

b. Special chambers may be required because of the wide variety of systems that could be tested (e.g., a large frame cargo aircraft to a small missile). The actual SUT may become a test fixture for its own interior. Airflow throughout the interior must be maintained and accommodations must be made to allow operators access for agent application, decontamination, and to perform contact or residual liquid sampling and vapor sampling.

c. The instrumentation used in test method conduct, sampling for residual liquid and vapor, and the analytical equipment for sample analysis are found in Paragraphs 2.2 and 2.2.1.

4.1.5.5 Hazards.

a. Identified safety hazards are those associated with testing using chemical surety materials, simulants, and decontaminant chemicals that are hazardous in and of themselves (e.g., chlorine, hydrogen peroxide, etc.). Chemical safety guidelines are found in DA PAM 385-61[15].

b. Testing conducted on large items of equipment may also have slipping or falling hazards[14] during decontamination operations on the SUT.

c. A test plan must be developed with a safety section identifying and addressing all safety concerns for each test conducted using the methods IAW AR 385-10[14]. The safety section of the test plan will be coordinated with the test site's safety office.

4.1.5.6 Calibration and Standardization.

a. The following analytical calibration guidelines can be used for most analytical instruments (e.g., GCs, LCs, etc.). A sample sequence will be created that includes the following:

(1) A solvent blank to evaluate method interferences.

(2) Calibration standards (preferably ranked low to high concentration) with at least five standards.

(3) A solvent blank to evaluate instrument carryover.

(4) A quality control (QC) sample to validate the calibration curve, at least one sample per detector (if multiple detectors are installed on the same instrument) including control samples.

(5) Another solvent blank.

b. The same method will be used to analyze all samples.

c. Plot information will be evaluated as follows:

(1) The appropriate curve fit type (linear, quadratic, etc.) will be selected.

(2) The appropriate point weighting (equal, inverse, etc.) will be selected.

(3) If the correlation value (R^2) is greater than 0.995, then test sample analysis will proceed.

(4) If R^2 is less than 0.995, then the standard solution producing the calibration point with the largest deviation will be replaced and a new calibration curve will be generated before processing test samples.

d. If all criteria are met, the QC sample will be loaded and processed against the calibration curve.

e. The calculated values for the QC sample must be within ±15 percent of the expected value.

f. If the QC calculated value passes, then the analysis method will proceed.

g. If the QC calculated value fails, then a second QC sample will be run.

h. If the second QC calculated value passes, then the analysis method will proceed.

i. If the second QC calculated value fails, then corrective actions will be taken and the instrument will be recalibrated.

j. After any maintenance action to the instrument, two QC samples must pass the ±15 percent criteria or corrective actions and recalibration must be performed.

4.1.5.7 Receipt Inspection and Functional Performance.

a. SUTs must be inspected for shipping damage, completeness of assembly, required accessories, and necessary manuals, logbooks, etc. Any missing components, damage, or other discrepancies noted will be documented.

b. Surfaces will be inspected for foreign materials normally not present on the item (e.g., dust, mud, grease, or marking). Foreign materials may be removed by brushing, vacuum cleaning, or washing with soapy water and sponge. The removal of foreign materials will minimize the bias that could create an over/under-estimate of the true contamination survivability of the system being tested. The surface condition, surface cleanliness, corrosion, materials of construction, variance from standard painting, and paint condition will be recorded.

c. Any functional SUT will be operated IAW the operator's manual. ME functional performance characteristics (e.g., electronic functions, shelter setup, etc.) identified by the combat developer (e.g., in the FD/SC) must be measured and recorded. Based on the selected functional performance characteristics, each functional performance characteristic should be designated as either a functional performance attribute (go or no-go) or as a functional performance variable measured over a continuous range of values. Each parameter must be measured at least twice and must be recorded to the smallest significant units of measure. If any damage, surface condition, or a ME functional performance characteristic falls outside developer specifications, then testing will not proceed.

4.1.5.8 Chemical Agents/Simulants.

a. The chemical agents to be used are as follows:

(1) Neat VX with a purity greater than 85 percent, unless weapons-grade is desired.

(2) Neat soman (GD) with a purity greater than 85 percent, unless weapons-grade is desired, and thickened with 5 percent (weight/volume) of Rohm and Haas Acryloid™ K125 (Philadelphia, Pennsylvania) poly(methyl methacrylate). This should provide thickened agent with a viscosity of 1,000 cSt at 20 °C. During preparation, batch-to-batch variability in viscosity may be greater than 10 percent. This large variability can be reduced by slowly adding the thickener over long periods of time. Complete solution of the polymer in GD is slow; therefore, mixing must continue until the measured viscosity is constant.

(3) Neat HD with a purity greater than 85 percent, unless weapons-grade is desired.

(4) Any of these chemical agents may be prepared with approximately 0.5 percent (weight/volume) of a suitable dye.

(5) Other approved contaminants [e.g., non-traditional agents (NTAs), toxic industrial chemicals (TICs), toxic industrial materials (TIMs)] as specified in the TEMP.

b. Simulants to be used are specified in the test plan. Simulants may be prepared with a suitable dye or thickener.

4.1.5.9 Test-Item Preparation.

Sample locations will be marked to ensure samples are taken from the same area. The area markings must outline the total area. Sample location identifiers must be outside the marked area. The sample location identifiers, descriptions, materials of construction, and surface geometry and texture, will be recorded.

4.1.5.10 Test Chamber Operation.

a. The test chamber will be operated using the procedures, controls, and SOPs approved for the Chemical agent in use. If an item is too large to fit properly in a chamber, testing may be conducted outdoors. Environmental conditions will be monitored, the SUT will be allowed to equilibrate with the ambient conditions, and any required background samples will be taken before contamination.

b. Some general technical data requirements for the test chamber are as follows:

(1) The test chamber environmental conditions should be computer-monitored, and data should be recorded at least every 5 minutes. The environmental conditions will include air temperature, RH, wind speed or air speed, test-item surface temperature, and differential pressure (chamber interior versus chamber exterior).

(2) The SUT will be placed in the chamber and the chamber stabilized at the environmental conditions specified for the test. The SUT will be conditioned until it has stabilized at 30±5 °C. Temperature and RH must be recorded continuously throughout the test.

(3) If an item is too large to fit properly in a chamber, testing may be conducted outdoors. Temperature, RH, and wind speed will be recorded throughout the test; however, they cannot be controlled. Testing will be conducted when meteorological conditions are as close to the optimum conditions as possible.

(4) Before CBR agent application, background liquid and vapor samples should be taken from or near areas designated for contamination testing. The sampling and analysis must be tailored to detect materials that could interfere with the chemical analysis for the agent being used.

4.1.5.11 Chemical Agent/Simulant Application and Weathering.

a. The mechanism for determining the actual amount of agent or simulant used to contaminate the SUT is called baseline contamination samples or baseline confirmation samples. The data collected from these samples will provide confidence that the agent/simulant dissemination method performed well and also provide the value for initial contamination. The selection of the appropriate baseline contamination density samplers is dependent on a test site's capability for providing and analyzing the samplers. Baseline samplers will be placed adjacent to the sampling locations. The samplers will be contaminated at the same time as the sampling location of the interior surface.

b. The selected areas of the interior surface will be contaminated with the chemical agent/simulant. Agent/simulant will be applied with a suitable dissemination device that has been calibrated and operated at the flow rate and pressure to achieve the drop size and contamination density specified in Paragraphs 4.1.2.2.a and 4.1.2.2.b, and/or the test plan. Precision dissemination device (e.g., pipette) calibration must be current and compliant with the required performance specifications listed in the most current versions of the International Organization for Standardization (ISO) 8655 Parts 1 and 2[20] or American Society for Testing and Materials (ASTM) E1154-89[21] for the volumes being delivered. If possible, photographs will be taken of drops on the contaminated test surface to record the deposition effects.

c. Immediately after contamination, the contamination density samplers will be removed and placed into sample jars with the appropriate solvent for analytical processing.

4.1.5.12 Decontamination of Interiors.

a. Decontamination must begin within the time interval specified in the CDD/CPD or test plan after completion of contamination. Standard procedures, decontaminants, and equipment (IAW FM 3-11.5[22]), and/or any system-specific procedures, when supplied as part of the test documentation package (i.e., the manual), will be used. If the decontamination process degrades the material or functionality, the effects must be documented.

b. Decontamination will begin with areas contaminated first and end with areas contaminated last. The decontamination process includes the following steps:

(1) Interior preparation consisting of specific procedures included in the test documentation package.

(2) Application of the decontaminant.

(3) Decontaminant contact time IAW specific procedures included in the test documentation package.

(4) Post-decontamination IAW specific procedures included in the test documentation package.

(5) Point-detector monitoring (if applicable) for residual contamination as described in Paragraph 4.1.5.13.b.

c. The time duration for each phase of the procedure must be documented.

d. The contaminated sampling areas should receive no more or no less attention, time, or effort than uncontaminated areas. Appropriate time should be spent on angles and hard-to-work areas.

e. Decontamination procedures must be documented. Video documentation is recommended, but still photographs can be used.

4.1.5.13 Post-Decontamination Sampling.

a. Point Detector Sampling. Operational post-decontamination sampling is conducted with point detectors or detector tape (M8). Fielded point detectors [e.g., Improved Chemical Agent Monitor (ICAM)] may be used for qualitative data purposes.

b. Liquid (Contact) Sampling.

(1) Locations on the system will be sampled where direct contact with the operator's skin or hands or prolonged contact with other clothed body parts is expected.

(2) Contact samplers [a thin, circular disk of latex rubber (1 mm thick) or other suitable material] will be prepared with a nominal size of 10 to 25 square centimeters (cm^2). Latex is the preferred material. Any other material used for a contact sampler must be free of powder. The contact sampler should be backed by aluminum foil (see Figure 1) to prevent contamination of the weight. When the sampling area is not even or contains irregularities, a material such as sponge rubber is inserted between the aluminum foil and the weight to force contact with all surface irregularities. The assembled sampler will be placed on the selected area creating a pressure evenly applied of 0.05-0.07 kg/cm² (or 0.7-1.0 pounds per square inch (psi) for 15 minutes. For the 2-inch diameter latex sampler, this is equivalent to a 2-inch diameter cylindrical mass weighing 1 kg. Additional contact samplers can be sequentially placed on the same area, for selected intervals of time up to a total of 60 minutes. Contact sampling is most appropriate for horizontal, even surfaces.

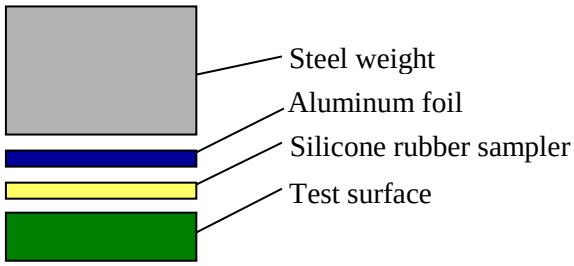

Figure 1. Diagram showing arrangement of test surface, silicone rubber disk, and steel weight for residual chemical agent liquid sampling.

(3) After reaching the appropriate time interval, the contact sampler will be immediately removed. The sampler will be placed in a sample jar and filled with the appropriate type and quantity of solvent. The jar will then be sealed and transported to a chemical laboratory for analysis.

(4) The 0-hour sample will be taken immediately after the decontamination rinse has dried. Additional samples will be taken at intervals determined in the test plan as necessary for

the specific CONOPS of the SUT (e.g., how long a human might be expected to lean on, touch, hold, etc., the area sampled).

c. Vapor Sampling.

(1) When a determination is made that the decontamination procedure is completed, vapor sampling can begin. The determination that the decontamination procedure is complete will be based on the technology being used (e.g., surface is dry from a liquid, samplers or time elapsed indicate the vapor is no longer present, etc.). Because it is difficult to sample the vapor from the entire surface within a large item, vapor samples can be taken at representative locations for future extrapolation to the total surface area of the system. Attention must be paid to locations where personnel exposure is expected.

(2) The sampling methods and or methodology must be detailed in the test plans and reports. Sampling methodology should consider the following items (this list is not exhaustive):

(a) Location and area of vapor sampling.

(b) Distance from the surface.

(c) Sampling frequency.

(d) Collection material (i.e., proper sorbent for collection).

(e) Sampler enclosure.

(f) Type of detector used and detector settings.

(3) Contaminated air will be aspirated through the SST (or other apparatus) at the appropriate rate and for the desired length of time (determined to minimize contaminant breakthrough) to trap contaminant vapor. Typically, MINICAMS® are aspirated at a rate of 0.5 L/min, SSTs may be aspirated from 0.5 to 1.0 L/min, and glass impingers (bubblers) are aspirated at a rate of 1.0 L/min.

(4) Samples will be taken at appropriate intervals that total the duration of the mission time described in the CONOPS. Generally, more chemical agent/simulant vapor will be given off during the first few hours of sampling and slowly decrease over time. Thus, sampling intervals may need to be short in the beginning and longer intervals later, when using cumulative sampling devices (e.g., bubblers or SSTs). This will avoid saturating cumulative sampling devices. A minimum of two SSTs should be obtained for any time interval (three samples are desirable), with the second sampler serving as a backup to the first sampler. A vapor-sampling sequence must be specified in the test plan. MINICAMS® are near real-time (NRT) samplers and the sample time setting selected will be determined to avoid saturating the detector.

d. Sample Analysis. Sample analysis should use analytical instruments and methods that give precise and accurate values for the primary data parameters. Data from military chemical alarms, detectors, detector papers, and kits (which provide only qualitative yes/no answers) should be used to complement data obtained from more precise analytical instruments.

4.1.5.14 Hardness Determination.

a. After completion of all decontamination and sampling procedures, all interior surfaces of the system will be inspected for visible evidence of degradation caused by the agents, decontaminants, and decontaminating procedures. Other signs of material degradation may include corrosion, peeling paint, discoloration, brittleness of rubber components, hazing or yellowing of plastic components, etc. Any degradation must be described and documented with photographs.

b. The process for identifying mission-critical system or infrastructure is outlined by the policy found in DODI 3150.09[5]. ME functions are those functions that define the successful completion of a mission for the system or infrastructure being tested as defined by the test sponsor and/or combat developer in the FD/SC. The SUT will be operated IAW the instruction manual, and all ME functional performance characteristics will be measured and recorded. Each parameter will be measured at least twice, depending on the inherent difficulty in reproducing a specific value, and compared with pretest values.

c. Hardness data collection must be performed after each C/D cycle and 30 days (or the specified time interval in the test plan) after the first contamination. Hardness data must be sufficiently accurate and precise to define any degradation after each C/D cycle and the specified time period.

d. The hardness and ME performance data collected will be compared with the pretest values recorded (Paragraph 4.1.5.7.c).

4.1.6 Adapting to Chemical Agent Simulant Testing.

a. Generally, the data requirements, facilities, and procedures for simulant testing will be similar to those used for chemical-agent testing. The major differences will be in the level of required safety and environmental protection restrictions, as well as the reduced approval requirements for test chamber work using simulant rather than those required for chemical agent work. Simulants must be used when a test is performed by Soldier, operator, maintainer, tester, and evaluator (SOMTE) personnel; when toxic test facilities are not available; when the nature of the equipment being tested makes the use of chemical agents impractical; or when an out-of-doors test setting is required. However, testing with simulants will only determine the effects of the decontaminant and the decontamination procedures. Any adverse effects that could be caused by chemical agents would not be determined or subject to evaluation.

b. Many SUTs that fail hardness testing fail not because of the agent contamination, but because of the wetting and/or corrosive action of the decontamination solutions and/or decontamination procedures on delicate optical, electronic, and mechanical components. Coordination with the test sponsor and the OTAs must be conducted for the specific combination of SUT, simulant, and decontamination procedure to determine if simulant testing adequately demonstrates survivability.

c. Proper selection of a simulant may effectively test certain aspects of survivability, but no single simulant test is likely to encompass all of the same aspects of survivability as well as chemical agent testing.

4.1.6.1 Facilities and Instrumentation.

a. The facilities required for simulant testing are the same as for agent testing, except for the test chamber and personnel protection requirements. The chamber size, environmental controls, and instrumentation will be the same as for chemical agent work; however, simulant testing usually requires less stringent safety and environmental protection equipment, and approval for testing will be needed.

b. Although the instrumentation required for simulant testing will generally be the same as for chemical agent testing, different sampling equipment and procedures may be required.

c. Simulant use makes outdoor testing possible. Under these conditions, the requirement for a test chamber is eliminated, but the need for other facilities and instrumentation remains the same.

(1) Outdoor testing will require that the acceptable temperature, RH, and wind speed limits are expanded to cover the variability expected during the test period. Deviations from requirements in Paragraph 2.2 must be documented. In addition, other environmental parameters will have to be included in the test plan, such as limits on precipitation, dew, solar radiation (sunshine), and cloud cover.

(2) Outdoor testing will result in more realistic environmental test conditions, but will complicate data analysis and comparison of different sets of test data.

4.1.6.2 Procedures.

Most aspects of simulant testing procedures will be the same as for chemical agent testing. These include objectives, criteria, controls and limitations, data required, receipt inspection, pretest preparation, test-chamber operation, test-item contamination, and test-item sampling. Safety procedures may be somewhat relaxed when working with simulants; however, test controls, test procedures, and data collection must be emphasized just as rigorously as when conducting agent testing.

4.1.6.3 Chemical Agent/Simulant Selection.

a. The selection of chemical compounds to simulate chemical agents is a critical step in testing with simulants. The test-item materials of construction and candidate simulant will be examined and compared with the CBME database[6] to ensure compatibility, i.e., that no degradation will be caused by the simulant that would not be caused by chemical agent. The simulants selected should be safe to handle and require minimum protective gear, equipment, and procedures; cause little or no environmental concern; and require minimum handling and storage problems.

b. Simulants selected for decontaminability testing must closely match the properties listed in Paragraph 4.1.5.8.a. Selected simulants must have similar chemical interactions with the decontaminants used, solubility in the decontamination solution, and a sensitive laboratory analysis procedure. Decontaminability and residual hazard data lose relevance without adequate side-by-side agent/simulant comparison data to confirm test procedure validity. Such agent/simulant comparison data must be obtained in a laboratory study. Experience has demonstrated that no single compound will simulate all of the important properties of the respective chemical agent. Performing replicate decontaminability tests using two or more simulants with different properties on each test may be needed to meet selected data requirements.

4.1.6.4 Simulant Decontamination.

The procedures used during decontamination will be the same as those used for chemical agent testing; however, the chemical reaction between the simulant and the decontaminating solution will not be the same or may not proceed at the same rate as with the actual chemical agent.

4.1.6.5 Simulant Sampling and Analysis.

The sampling devices used to sample the simulant should be selected to be as sensitive as those used in chemical-agent testing. The analytical procedure must be able to identify and measure the simulant to the same sensitivity as the chemical agent for which the simulant is a surrogate.

4.2 Biological Contamination Survivability Testing.

4.2.1 Objectives.

a. Decontaminability. Determine the ability of a system to be rapidly (less than 75 minutes)[10] and effectively decontaminated following exposure to an ABO or simulant. Measure the associated hazard on equipment that has been contaminated with biological contaminant and decontaminated using standard and/or item-specific decontamination procedures.

b. Hardness. Determine the capability of a system to withstand the material-damaging effects of biological agent and/or relevant decontaminations. Measure the degree of performance degradation for ME functions of military mission-critical material after biological agent C/D by standard and/or item-specific procedures.

4.2.2 Criteria and Conditions.

4.2.2.1 Criteria.

a. Decontaminability. After rapid decontamination[10], residual contamination levels for the equipment must constitute a negligible risk to unprotected military users of the equipment (see QSTAG 747[11]). In the determination of biological survivability, the CBCS test conditions listed in Paragraph 4.2.2.2 apply.

b. Hardness. Materiel developed to perform ME functions shall be hardened to ensure that exposure to the specified CBR C/D cycles does not degrade the ME performance of the equipment more than 20 percent or that specified by the combat developer measured over a specified time or mission duration[10]. The number of C/D cycles for biological survivability must consider pandemic events and the requirements imposed by the affected countries.

4.2.2.2 Conditions.

a. General Conditions. The time frame to start decontamination will be determined by the CDD or test-plan requirements. Standard field and/or item-specific decontaminants, equipment, and procedures will be used.

b. Detailed Conditions. If not already specified in the capabilities document, the detailed conditions for biological contamination survivability testing will be as follows:

(1) Chamber temperature: 30±5 °C.

(2) RH: ambient ±1 percent.

(3) Test chamber air circulation: ≤1 m/s.

(4) Exterior contamination density: $1 \pm 0.5 \times 10^7$ CFU/m^2.

(5) Particle size: 1 to 5 µm.

4.2.3 Controls and Limitations.

The controls and limitations for biological agent contamination survivability testing are:

a. Test Surface Controls.

(1) For mock-up or panel testing, the materials, paint type, specifications, and application must comply with system specification for the SUT.

(2) Surface areas selected for sampling must be representative of the interior surface paint, materials, and texture, including the areas where the user will have direct contact.

b. Sample and Analysis Controls.

(1) Swab control (unused swab).

(2) Swab of an uncontaminated surface.

(3) Diluent control.

(4) Plate control.

(5) A maximum of 18 hours between sample collection and analysis.

4.2.4 Data Required.

a. Test Chamber or the System Interior.

(1) Temperature in °C.

(2) RH in percent.

(3) Airflow through the interior in m/s.

b. Biological Agent or Simulant.

(1) Name, control number, and spore manufacturer.

(2) Diluent used.

(3) Percent solids.

(4) Date prepared and/or reconstituted.

(5) Quality of spore preparation (greater than 90 percent desired).

(6) Date used.

(7) CFU per mL.

(8) Dissemination equipment used.

(9) Quantity of biological agent/simulant suspension disseminated in mL.

(10) Disseminator air pressure in psi.

(11) Dissemination time in seconds.

(12) Still color photographs and written description of each area contaminated.

(13) Contamination density for each sampling area before and after decontamination, expressed in CFU/sample.

c. Sample history with elapsed time to analysis in hours.

d. Elapsed time required to complete contamination, weathering time before decontamination, and decontamination time, in minutes.

e. Description of the decontaminant solutions (i.e., formulation, active ingredients, and age), methods and/or methodology, equipment, lot number, and item-specific procedures used.

f. Description of SUT-interior materials of construction, paint type, and surface condition (pretest and posttest), including cleanliness (mud, grease, etc.). Photographs should be made of

joints, crevices, textures, or other areas that may be difficult to decontaminate or allow liquid to penetrate.

g. Pretest and posttest ME functional performance characteristics (when measured) used as the measure of the SUT's mission performance before and after exposure to contaminants, decontaminants, and decontaminating procedures.

h. Any safety issues described.

4.2.5 Methods and Procedures.

4.2.5.1 Test Method Outline.

a. The biological agents/simulants are prepared for application. Paragraph 4.2.5.6 describes the details for this step of the test method.

b. Receipt inspection is conducted on the SUT to document as-tested material conditions. Receipt inspection may include functional performance tests to establish baseline performance parameters (e.g., computer is operational, aircraft avionics are operational, etc.). Paragraph 4.2.5.7 describes the details of this step.

c. SUT is prepared for testing to include: sample location, identification, and documentation; marking of sample areas; etc., as described in Paragraph 4.2.5.8.

d. The disseminator is prepared for operation. Paragraph 4.2.5.9 describes the details of this step.

e. For test chamber operation or when the SUT is the chamber, environmental conditions will be verified and stabilized. Paragraph 4.2.5.10 describes the details of this step.

f. Any background samples will be taken before contaminant application. Paragraph 4.2.5.11 describes the details of this step.

g. Biological agents/simulants are applied to the SUT IAW Paragraph 4.2.5.12.

h. Post-contamination samples (contamination density verification) will be taken as described in Paragraph 4.2.5.13.

i. Decontamination operations will be conducted on the SUT IAW Paragraph 4.2.5.14.

j. Post-decontamination sampling will be conducted IAW Paragraph 4.2.5.15.

k. Hardness and post-decontamination functional performance measurements will be performed IAW Paragraph 4.2.5.16.

l. Sample analysis will be performed as described in Paragraph 4.2.5.17.

m. Data presentation and hazard determination procedures are in Paragraph 6.3.

4.2.5.2 Significance and Use

a. The sample data collected from this test allow a determination of biological spore hazards to unprotected military personnel from decontaminated military materiel.

b. The functional performance and/or material effects data collected will allow a determination of the amount of physical or functional degradation of the system resulting from CBR contamination, decontamination procedures, and materials, to determine if there is a hardness issue.

4.2.5.3 Interferences.

There are no anticipated interferences when the test method is conducted under laboratory-controlled conditions.

4.2.5.4 Apparatus.

a. The term apparatus will be used to cover the test fixture in which the test may be conducted as well as the equipment used in conducting testing, sampling, and analytical instrumentation.

b. If a large test item presented for interior testing cannot fit within an existing test chamber, then testing may be conducted inside the SUT.

c. The instrumentation used in test method conduct, sampling for residual biological organisms, and the analytical equipment for sample analysis are found in Paragraphs 2.2 and 2.2.2.

4.2.5.5 Potential Hazards During Test Conduct.

a. Follow all safety protocols to address any hazards in working with the selected biological simulants. Biological safety guidelines are found in DA PAM 385-69[16].

b. There are safety issues when testing with decontaminant chemicals that are hazardous[16] (e.g., chlorine, hydrogen peroxide, etc.).

c. Testing conducted on large items of equipment may also have slipping or falling hazards[14] when attempting to conduct decontamination operations on the equipment.

d. A test plan must be developed with a safety section identifying and addressing all safety concerns for each test conducted using these methods IAW AR 385-10[14]. The safety section of the test plan will be coordinated with the test site's safety office.

4.2.5.6 Biological Agent/Simulant Preparation.

a. The rationale for the selection and use of any biological simulants must be documented in the test report.

b. Procedure controls and SOPs in effect at the time for biological simulant testing must always be followed.

c. The biological organism (agent or simulant) used for testing will be characterized for proper particulate size profile (1 to 5 µm) and quality of spore preparation (greater than 95 percent spores).

d. As new decontaminants are developed, a live biological agent efficacy test must be conducted for screening purposes. In addition, it is possible that biological simulants currently used will not be appropriate and a new simulant must be selected. If a new simulant is selected, an agent/simulant relationship must be established. The rationale for simulant selection, agent/simulant relationship, and live agent efficacy test results must be documented in the test report.

4.2.5.7 Receipt Inspection and Functional Performance.

A receipt inspection and pretest ME functional performance test, as described in Paragraph 4.1.5.7, will be performed if not previously performed as part of another test phase of the CBRCS test.

4.2.5.8 System Interior Preparation.

Sampling locations will be marked to ensure samples are taken from the same area. For biological contamination survivability (CS), three closely located 25-cm^2 sample areas will be marked for each location selected (see Figure 2). At each sampling location, three samples will be collected: (1) background, (2) post-contamination, and (3) post-decontamination. Only the boundary of the area must be marked; no markings must be made within the boundary. Sample location numbering or other designation must be marked outside the boundary.

Figure 2. Example of three closely located sampling areas with sampling sequence indicated.

4.2.5.9 Disseminator Preparation.

A disseminator (air driven or liquid slurry) will be calibrated to disperse the test organism containing particles in the 1 to 5 μm size range. The appropriate operating time, air pressure, and slurry concentration will be determined for the disseminator. The exact slurry count, the generator air pressure, the duration of generator operation, and the number of CFU/L of chamber air to meet the SUT-contamination target of 1×10^8 CFU/m^2 will be determined by the project biologist.

4.2.5.10 Test Conduct.

The chamber or system acting as a chamber will be brought to the environmental conditions specified for the test, and stabilized for a minimum of four hours. Temperature, RH, and airflow will be recorded at a minimum of every 5 minutes for the duration of the test.

4.2.5.11 Background Sampling.

Before contamination, the first of the three collocated 25 cm^2 sampling areas at each location will be swab-sampled to determine the background contamination level and residual substances (decontaminant) that could interfere with sample analysis.

4.2.5.12 Biological Agent/Simulant Application.

a. The air inside the chamber will be contaminated to a level of approximately $l \times 10^6$ CFU/L of air.

b. One hour will be given for contamination to settle on the SUT (when an air-driven disseminator is used). After the settling, the chamber will be air washed for 1 hour to reduce chamber contamination. The 1-hour air wash can also serve as the 1-hour weathering time.

4.2.5.13 Post-Contamination Sampling.

After any air wash, the second of the three collocated 25 cm^2 sampling areas will be swab-sampled to determine the contamination density at each respective location.

4.2.5.14 Decontamination of the SUT.

a. Decontamination will begin immediately after post-contamination sampling. Standard decontamination procedures, solutions, and equipment; or any SUT-specific procedures furnished to the test team as part of the test documentation package will be used to decontaminate the SUT.

b. Decontamination procedures will be performed as if the entire interior surface of the test system were uniformly contaminated.

c. All decontamination procedures, equipment, tools, and time used in the decontamination process, including item-specific procedures, will be recorded.

4.2.5.15 Post-Decontamination Sampling.

a. When the surface is dry following decontamination, the third 25 cm^2 area will be swab sampled at each sample location to determine the residual contamination remaining after decontamination.

b. For porous materials such as upholstery, ceiling tiles, etc., a coupon of the material will be extracted with saline solution, which must then be filtered, cultured, and counted.

4.2.5.16 Hardness Determination.

a. After biological decontamination is complete and the final set of swab samples have been taken, all interior surfaces of the item will be inspected for visible evidence of degradation caused by the contaminants or decontaminants. Degradation will be described and documented with photographs.

b. The process for identifying mission-critical system or infrastructure is outlined by the policy found in DoDI 3150.09[5]. ME functions are those functions that define the successful completion of a mission for the system or infrastructure being tested as defined by the test sponsor and/or combat developer in the FD/SC. The SUT will be operated and all ME functional performance characteristics will be measured and recorded. Each parameter will be measured at least twice, depending on the inherent difficulty in reproducing a specific value, and compared with pretest values.

4.2.5.17 Analysis of Biological Samples.

Analysis of the biological samples is done as follows:

a. The samples are placed on appropriate plates.

b. The prepared plates are incubated for 14 to 18 hours at 37 °C.

c. After incubation, count and record the number of colonies on the plates.

4.3 Radiological Contamination Survivability Testing.

4.3.1 Objectives.

a. Decontaminability. Determine the ability of a system or infrastructure interior to be rapidly (less than 75 minutes)[10] and effectively decontaminated following radioactive particulate exposure. Hazards associated with the warfighters' use of equipment that have been contaminated with radiological particulate and decontaminated using standard and/or item-specific decontamination procedures shall be determined. The activity considered in this test would result from residual radioactive particulate such as the fallout from a nuclear weapon or radiological dispersal device.

b. Hardness. Determine the capability of a system or infrastructure interior to withstand the material damaging effects of radiological particulate and/or relevant decontaminations.

Measure the degree of performance degradation in ME functions of military mission-critical material after radiological debris C/D by standard and/or item-specific procedures.

4.3.2 Criteria and Conditions.

4.3.2.1 Criteria.

a. Decontaminability. The interior surfaces of materiel developed to perform ME functions shall be designed so that radiological contamination remaining on the surface following decontamination shall not result in more than a negligible risk to unprotected military users of the item[10]. In the determination of risk level, the conditions listed in Paragraph 4.3.2.2 apply.

b. Hardness. Mission-critical equipment shall be hardened to ensure that exposure to radiological C/D cycles does not degrade the operational ME performance of the equipment by more than 20 percent (or that specified by the combat developer) measured over a 30-day period, or as defined by the capabilities documents.

4.3.2.2 Conditions.

a. General Conditions.

(1) The sequence of events for the decontamination process will be IAW the CDD, CPD, or test plan requirements. Standard field and/or item-specific decontaminants, equipment, and procedures will be used.

(2) Hazard levels will be calculated assuming an exposure time based on the CONOPS/concept of employment (COEs), as specified by the combat developer.

b. Detailed conditions[10].

(1) Test chamber: temperature 30±5 °C.

(2) Ambient RH.

(3) Airflow (air circulation around the SUT): ≤1 m/s.

(4) Radiological fallout simulant. Short half-life isotope should have no more than 185 gigabecquerel (GBq)/m^2 gamma activity.

(5) Radioactive fallout simulant particle size: 37 to 200 µm in diameter.

(6) Interior target contamination density: 0.4 g/m^2 (this is one-tenth of the contamination density for exterior surfaces).

(7) Sampling and counting controls: SUT background control, laboratory control, and sample counting control.

(8) Surface areas selected for sampling must be representative of the SUT materials, surface texture, paint, and areas where the user will have contact with the item.

(9) Contamination weathering time before start of decontamination will be 1 hour after completion of contamination.

4.3.3 Controls.

a. The test system interior surfaces must be representative of an operational system.

b. Surface areas selected for sampling must be representative of the interior surface paint, materials, texture, and the areas where the user will have direct contact.

4.3.4 Data Required.

a. Description of the interior materials of construction, paint type, and surface condition, including cleanliness (mud, grease, etc.). Photographs of joints, crevices, textures, or other objects that may prove difficult to decontaminate will be included.

b. Photograph and written description of each area selected for sampling.

c. System interior or chamber: temperature in °C, RH in percent, and airflow in m/s.

d. Complete simulant description, including (as applicable): source, lot number, particle count/g, and particle size range in μm.

e. Disseminator used, operating air pressure in kilo Pascals (kPa), dissemination time in seconds, mass of simulant disseminated in grams, and chamber air-contamination density in particles/L of air.

f. Background particle counts, interior surface contamination density counts, residual contamination (post-decontamination) in particle/cm^2, and QC values.

g. All pertinent test event times and sample times in minutes.

h. A description of decontamination methods and/or methodology, equipment, solution (if used), and any SUT-specific decontamination procedures and special devices used.

i. Results of the visual inspection of the SUT surfaces after each C/D cycle.

j. Pretest (background) and posttest ME functional performance data used to determine SUT hardness (degradation).

k. Description of any safety issues.

4.3.5 Methods and Procedures.

Simulants that are used must have documentation provided with the rationale for selection and particle size range.

4.3.5.1 Test Method Outline

a. Receipt inspection and pre-test ME function baseline measurements are conducted to document as-tested system interior conditions. These procedures are found in Paragraph 4.3.5.6.

b. Surface interior preparation procedures will include sample location identification, documentation, and marking of sample areas (Paragraph 4.3.5.7).

c. Background sampling procedures (Paragraph 4.3.5.8).

d. Chamber operations for mock-ups, panels, or if the system is the chamber (Paragraph 4.3.5.9).

e. Simulant application procedures (Paragraph 4.3.5.10).

f. Post-contamination sampling procedures (Paragraph 4.3.5.11).

g. Decontamination procedures (Paragraph 4.3.5.12).

h. Post-decontamination sampling procedures (Paragraph 4.3.5.13).

i. Sample analysis will be conducted as described in Paragraph 4.3.5.14.

j. Hardness determination procedures (Paragraph 4.3.5.15).

k. Data presentation procedures (Paragraph 6.4).

4.3.5.2 Significance and Use.

The sample data collected from this test allow a determination of the radiological hazards from decontaminated military materiel to unprotected military personnel.

4.3.5.3 Interferences.

None.

4.3.5.4 Apparatus.

Testing may be conducted in a variety of system interiors or chambers which cannot be listed in this document.

4.3.5.5 Potential Hazards.

Short half-life isotopes are a personnel hazard and will require proper licensing, storage, monitoring, handling, and disposal procedures. Non-radioactive isotopes may require similar procedures, but must not present radiological hazards to personnel.

4.3.5.6 Receipt Inspection.

A receipt inspection and pretest ME functional performance test, as described in Paragraph 4.1.5.7, will be performed if not previously performed as part of another test phase of CBCRS testing.

4.3.5.7 Surface Area Preparation.

Sample area preparation will depend upon the type of simulant used:

a. For non-isotope sampling, identify and mark three closely located 4 cm^2 sampling areas (see Figure 2). Only the boundary of the area must be marked. No markings must be made within the boundary. Sample location numbering or other designation must be marked outside the boundary.

b. When using non-radioactive isotopes or short half-life isotopes, identify and mark sampling areas, especially where particulates may collect, such as crevices, rough surfaces, corners, etc. These same areas may be used for background, post-contamination, and post-decontamination sampling.

4.3.5.8 Background Samples.

a. For non-isotope counting only, before contamination, the first of the three collocated sampling areas will be sampled to determine if a background contamination level exists that could interfere with sample analysis. Sample collection methodology must be described in the test plan.

b. For non-radioactive or short half-life isotopes, take a background sample at each sample location. The short half-life isotope sampling will be conducted using a quantifying radioactivity detector. Describe the detector capabilities and limitations in the test plan.

4.3.5.9 Chamber Operations.

a. The test chamber (mock-ups or panels) will have environmental conditions established and be allowed to stabilize for at least two hours before testing.

b. The test system interior (when the system is the chamber) will have environmental conditions established and be allowed to stabilize for at least six hours before testing.

4.3.5.10 Simulant Application.

a. The disseminating apparatus will be calibrated for the simulant application.

b. Disseminate the simulant into the system interior, or onto the mockups/panels.

c. Allow one hour for contaminant settling before taking additional samples.

4.3.5.11 Post-Contamination Sampling.

a. For non-isotope counting only, after contamination, the second of the three collocated sampling areas will be sampled using the procedure described in Paragraph 4.3.5.8.

b. For non-radioactive or short half-life isotopes, take a post-contamination sample at each sample location.

4.3.5.12 Decontamination Procedures.

a. Decontamination will begin immediately after contamination density sampling. Standard decontamination procedures, solutions, and equipment or any SUT-specific procedures furnished as part of the test documentation package will be used.

b. Decontamination procedures will be performed over the entire interior surface of the SUT. Appropriate time should be spent on rough surfaces, joints, angles, and hard-to work areas.

4.3.5.13 Post-Decontamination Sampling.

a. For non-isotope counting only, after contamination, sample the third of the three collocated sampling areas using the procedure described in Paragraph 4.3.5.8.

b. For non-radioactive or short half-life isotopes, take a post-contamination sample at each sample location.

4.3.5.14 Sample Analysis.

Non-radioactive isotopes will be submitted for analysis using appropriate techniques and instrumentation that will be described in the test plan. Any rationale for selection of the analytical methodology will be included.

4.3.5.15 Hardness Determination.

a. After radiological decontamination is complete and the final set of samples has been collected, the interior of the system will be inspected for any visible changes (e.g., deterioration, corrosion, or buildup of deposits) caused by the test procedures that could affect SUT's performance. The system will be operated and all ME functional performance characteristics will be recorded. Each parameter will be measured at least twice, depending on the inherent difficulty in reproducing a specific value. The post-C/D values will be compared with pretest values.

b. The process for identifying mission-critical system or infrastructure is outlined by the policy found in DODI 3150.09[5]. ME functions are those functions that define the successful

completion of a mission for the system or infrastructure being tested as defined by the test sponsor and/or combat developer in the FD/SC.

c. Any indication of operational degradation attributable to the radiological C/D cycle will be recorded.

4.4 Long Term CBR Hardness.

4.4.1 Objective.

Determine the long-term (as specified in the capabilities documents, but greater than 30 days[10]) effects of CBR contamination and CBR decontamination procedures.

4.4.2 Criterion.

None. There is no criterion for hardness determination for a time period greater than 30 days.

4.4.3 Hardness Determination.

At the conclusion of the long-term period, the interior of the SUT will be visually inspected for evidence of degradation caused by the test procedures, and any visible effects will be recorded. The SUT will be operated, and all ME functional performance characteristics will be measured and recorded. Each parameter will be measured at least twice, depending on the inherent difficulty in reproducing a specific value. The posttest values will be compared with pretest values. Procedures and data required are the same as those described for chemical hardness in Paragraph 4.1.5.14.

5. DATA REQUIRED.

The data required are listed in Paragraph 4 for each subtest.

6. PRESENTATION OF DATA.

6.1 Receipt Inspection Data.

a. Receipt inspection data must include a description of the as-received SUT or mock-up, identifying any damage and specific conditions of the surface to be exposed to agents, biological spores, or radiological fallout simulant. Receipt inspection photographs are important. Differences between the mock-up and SUT must be described. Receipt inspection photographs of exterior materials, construction, paint, cleanliness, joints and crevices will be required.

b. All data will be reported on system interior damage, missing components, surface condition, history, and other discrepancies. Results will be summarized and presented in tabular form, including surface cleaning or maintenance performed, and emphasizing deviations from developer specifications.

c. Mock-up receipt-inspection data will be reported, noting differences between the mock-up and the SUT.

d. Data pertaining to surface materials and their finishes will be reported in a form that can be compared with pretest and posttest hardness functional performance data.

6.2 Chemical Contamination Survivability Data.

6.2.1 Decontaminability Data.

a. Chemical decontaminability will be determined by comparing post test results against established criteria (see Paragraph 4.1.2.1). The item will be considered decontaminable if residual vapor dosage and liquid mass sampling results are reduced to levels at or below the established decontaminability criteria[10].

b. Decontamination efficacy will be reported. Decontamination efficacy is defined as:

$$\text{Decontamination Efficacy} = [(C_i - C_d)/C_i] \times 100;$$

where (C_i) is the initial contamination density and C_d is the residual contamination after decontamination operations.

c. Each sampling area, including the location, material of construction, surface geometry, and surface texture, will be reported.

d. The contaminant, contamination procedure, decontaminant, and the decontaminating procedures used, including item-specific procedures and time expended on each procedure will be reported in the test report. Decontamination operation video coverage and/or any still photographs taken will be made available.

e. The chamber conditions during the test period will be summarized in a table.

f. The chemical agent physical properties, agent contamination density, and the drop size for each item or sampling area will be presented in a table. Deviations from specified values will be identified.

g. The quantity of agent recovered from each agent contact sampler, identified by the location and time at which the sample was taken, will be tabulated.

h. The concentration of chemical agent vapor recovered from each test-item sampling location (or component, if used) and time period should be represented in table format.

i. The agent vapor mass results will be processed through the downwind hazard prediction model[18] and the calculated dosages will be compared with the DA approved NBCCS criteria for mission-critical materiel[10].

(1) No simple procedure exists for determining vapor hazard to the test-item operator(s). The credible dosage received is a function of agent desorption from the decontaminated SUT, worst-case, or other selected scenarios that have almost unlimited variables.

(2) One approach[23] would be to calculate toxic load from the agent vapor dosages measured from a SUT. This approach allows the toxic load calculations to be transferred to exposure scenarios on a case-by-case basis, depending on the SUT and its expected use in the field.

j. Failure of the decontaminability criteria may necessitate the testing of individual materials.

k. A sample analysis table of chemical agent and decontaminant effects is provided as Table 1.

TABLE 1. SAMPLE DATA FORM.

ANALYSIS OF CHEMICAL AGENT AND DECONTAMINATION EFFECTS ON THE WIDGET X			
Component	Material	Agent Effects	Decontaminant Effects
Plate	Sheet titanium, grade 2	Not expected to have any effect.	Not expected to have any effect.
Foam element no. 1	Cushioning material, packing closed cell foam planks	Expected to absorb and desorb chemical agents and trap nuclear and biological agents. May disintegrate when exposed to chemical agents.	May disintegrate when exposed to decontaminats.
Sealant	Manganese dioxide cured polysulfide compound	There is no data in the CBME database for manganese dioxide. Polysulfide is expected to absorb and desorb agents.	There is no data in the CBME database for manganese dioxide.
Sealant	Aerospace Sealant, part no. ABCD-12	Will sequester agents and may pose an off-gassing hazard with agent vapors if directly contaminated with agents.	May cause hardening or swelling of the sealant, which may weaken the seal.
Rivet	Stainless steel	Not expected to have any effect.	Not expected to have any effect.

6.2.2 Hardness Data.

a. Hardness data will be presented in a format to show direct comparison of pre- and post-exposure ME function performance of the SUT.

b. All ME function performance data, identified by test cycle number, chemical agent, and decontaminant will be summarized and tabulated.

c. The ME function performance data for each C/D cycle will be compared with the receipt inspection performance data. The ME performance data will be used to determine whether more than 20 percent degradation in item performance (or that specified by the combat

developer) has occurred (Paragraph 1.3 b). Significant results based on operator interview data will be discussed in the report.

6.3 Biological Contamination Survivability Data.

6.3.1 Decontaminability Data.

a. For each ABO or simulant used, the contamination density (CFU), chamber temperature, humidity and airflow conditions will be reported. Also, decontamination solutions, equipment, procedures, and decontamination time will be reported. The results (i.e., residual contamination in CFU) will be compared with the contamination density and tabulated. A 6-log reduction from the contamination density will be the minimum acceptable level[10].

b. Each sampling area will be described (photographs are preferable), including the location, material of construction, surface geometry, and surface texture.

c. The decontaminant, decontamination time, and decontaminating procedures used, including item-specific procedures furnished by the materiel developer, will be reported.

d. The chamber conditions during the test period will be summarized.

e. Test organism physical property data and aerosol disseminator operating data will be described. Any deviations from target values will be identified and explained.

f. For each sample location, the CFU recovered from the control samples, the test-item contamination level, and the residual sample level after decontamination will be tabulated.

g. The decontamination reduction ratio achieved by the decontamination process (the item challenge contamination level divided by the residual contamination level) for each sampling location will be calculated. The CFUs (spores that have become viable cells) that are sampled after decontamination will be divided by the number of CFUs sampled after contamination of the SUT. This reduction ratio will be expressed as the log reduction. The reduction ratio and the raw challenge and residual data will be presented in tabular form. The item will successfully meet the criterion[10] for biological decontaminability and be considered decontaminable for biological agent if the contamination of the system has a 6 log or greater reduction.

6.3.2 Hardness Data.

a. Hardness data will be presented in a format to show direct comparison of pre- and post-exposure ME function performance of the SUT.

b. The ME function performance data for each C/D cycle will be compared with the receipt inspection performance data. The ME performance data will be used to determine whether more than 20 percent degradation in item performance (or that specified by the combat developer) has occurred (Paragraph 1.3 b). Significant results based on operator interview data will be discussed in the report.

6.4 Radiological Contamination Survivability Data.

6.4.1 Decontaminability Data.

a. In the test report, each sampling area will be described (photographs are preferable), including the location, material of construction, surface geometry, and surface texture.

b. The decontaminant, decontamination time, number of decontamination cycles, and decontaminating procedures used, including item-specific procedures furnished by the materiel developer, will be reported.

c. The chamber or system interior environmental conditions will be presented in a table.

d. Complete simulant description will be recorded.

e. Disseminator operating data will be recorded. Any deviations from target values will be identified and explained.

f. The data for each sample location (background, post-contamination, and post-decontamination) will be presented in tabular form.

g. For the non-isotope or non-radioactive isotope data, the reduction ratio achieved (the residual contamination level divided by the challenge contamination level, expressed as a percentage) will be calculated and included in the data table. If the reduction ratio is 50 percent or greater, the system will be considered decontaminable.

h. For the short half-life isotope data, the calculated decontamination values will be compared with the CS criterion and included in the data table. The item will be considered decontaminable for radiological particles if the contamination is reduced to levels below the established criterion[10].

6.4.2 Hardness Data.

a. Hardness data will be presented in a format to show direct comparison of pre- and post-exposure ME function performance of the SUT.

b. The ME function performance data for each C/D cycle will be compared with the receipt inspection performance data. The ME performance data will be used to determine whether more than 20 percent degradation in item performance (or that specified by the combat developer) has occurred (Paragraph 1.3 b). Significant results based on operator interview data will be discussed in the report.

6.5 Long Term CBR Hardness Data.

Long-term hardness (greater than 30 days) data will be presented in a format to show direct comparison of pre-exposure and long-term post-exposure ME function performance of the SUT.

APPENDIX A. EXPLANATION OF TERMS.

Capability Document. A document that captures the capabilities specific to the initial concept, development, or production of a program.

Capability Development Document (CDD). A document that captures the information necessary to develop a proposed program(s), normally using an evolutionary acquisition strategy. The CDD outlines an affordable increment of militarily useful, logistically supportable, and technically mature capability.

Capability Production Document (CPD). A document that addresses the production elements specific to a single increment of an acquisition program.

Chemical Biological (CB) Compatibility. The capability of a system to be operated, maintained, and resupplied by persons wearing a full complement of individual protective equipment, in all climates for which the system is designed and for the period specified in the Capability Development Document (CDD) or Capability Production Document (CPD).

CB Decontaminability. The ability of a system to be rapidly and effectively decontaminated to reduce the hazard to personnel operating, maintaining, and resupplying it.

CB Decontamination. The process of making material safe by absorbing, destroying, neutralizing, rendering harmless, or removing chemical or biological agents and contamination.

CB Environment. The environment created by chemical or biological contamination.

CB Hardness. The capability of material to withstand the material-damaging effects of CB contamination and relevant decontaminations.

Chemical, Biological, Radiological (CBR) Contamination Survivability (CBRCS). The capability of a system to withstand CBR contaminated environments, decontaminants, and decontamination processes, without losing the ability to accomplish the assigned mission. A CBR-contaminated survivable system is hardened against CB agent(s) or radiological contamination and decontaminants. It can be decontaminated, and is compatible (operable) by individuals wearing individual protective equipment. CBRCS may be accomplished by hardening, timely resupply, redundancy, mitigation techniques (to include operational techniques), or a combination thereof. The elements of CBRCS covered by this TOP are compatibility, decontaminability, and hardness.

Chemical, Biological, Radiological, and Nuclear (CBRN) Survivability. The capability of a system to avoid, withstand, or operate during and/or after exposure to a CBR environment (and relevant decontamination) and a nuclear environment, without losing the ability to accomplish the assigned mission. CBRN survivability is divided into CBR survivability, which is concerned with CBR contamination to include fallout, and nuclear survivability, which covers initial nuclear weapon effects including electromagnetic pulse (EMP).

Combat Developer. A category of sponsor responsible for drafting, staffing, and revising capabilities documents.

APPENDIX A. EXPLANATION OF TERMS.

Initial Capabilities Document (ICD). Documents the need for a materiel approach or an approach that is a combination of materiel and non-materiel to satisfy a specific capability gap(s). It defines the capability gap(s) in terms of the functional area, the relevant range of military operations, desired effects, time, and doctrine, organization, training, materiel, leadership and education, personnel, and facilities (DOTMLPF) and policy implications and constraints. The ICD summarizes the results of the DOTMLPF analysis and approaches (materiel and non-materiel) that may deliver the required capability. The outcome of an ICD could be one or more joint DOTMLPF change recommendations or capability development documents.

Material Developer. The organization responsible for research, development, and acquisition of material systems in response to capabilities documents.

Mission Critical System. A system whose operational effectiveness and operational suitability are essential to successful mission completion or to aggregate residual combat capability. If this system fails, the mission likely will not be completed. Such a system can be an auxiliary or supporting system, as well as a primary mission system.

Neutron-Induced Gamma Activity. The radioactivity of elements, typically in soil, induced by neutrons produced by a nuclear burst. The induced radioactivity produces gamma and beta radiation.

Sponsor. The organization responsible for drafting, staffing, and revising capabilities documents. For purposes of this TOP, sponsors include Combat Developers.

System Threat Assessment. A predecessor document that is used to summarize in a CDD the projected threat environment and the specific threat capabilities to be countered. The summary includes the nature of the threat, threat tactics, and projected threat capabilities (both lethal and nonlethal) over time.

APPENDIX B. TEST EQUIPMENT.

Thermocouple.

Hygrometer.

Anemometer.

Still color camera.

Video camera.

Bubblers, MINICAMS® (OI Analytical, division of OI Corporation, College Station, Texas), solid sorbent tubes (SSTs), or equivalent.

Filter papers, photographic paper, or equivalent. Software for calculations.

Gas chromatograph (GC), high-performance liquid chromatograph (HPLC), liquid chromatograph (LC), spectrophotometer, or equivalent.

Silicone rubber, latex dental dam, or equivalent. Rubber sampler must be unflavored, uncolored, heavy gauge (approx. 0.10 inch thick).

Compressed air dry powder disseminator.

Air-driven liquid-slurry disseminator.

Microscopes, automatic colony counters, or equivalent, swabs or wipes placed in growth medium.

Radioactivity detector.

Stop watches or equivalent.

Vacuum pump to pull air through bubblers or SSTs.

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APPENDIX C. MATERIAL PROPERTIES MATRIX.

The material properties matrix provides a useful tool for program managers, testers, and database developers to acquire the information needed to ensure that defense systems are survivable to the effects of chemical, biological, and radiological (CBR) contamination and the decontamination process. This matrix details the critical properties of materials that program managers and testers should test to determine if mission-critical systems are survivable in a CBR environment by measuring any significant degradation to these critical properties. While survivability determinations are not limited to the materials and properties listed in this matrix, it provides a minimum framework for data that program managers and testers should provide to the chemical and biological materials effects (CBME) database[6] so that appropriate survivable materials can be selected during the design of new systems or system upgrades.

APPENDIX C. MATERIAL PROPERTIES MATRIX.

TABLE C-1. MATERIALS AND PROPERTIES OF INTEREST.

		Properties	Metals	Laminates	Adhesives/Sealants/ Joints (Including Welds)	Coatings	Potting Compounds	Optical Materials (Metal Oxides, Plastics, etc.)	Elastomers	Plastics	Composite Materials	Petroleum, Oil, and Lubricants (POL)	Textiles	Ceramics
Agent Effects	1	Agent absorption (µg/cm^2 absorbed per time period) and agent desorption (µg/cm^2 desorbed per time period)		X	X	X	X	X	X	X	X		X	X
	2	Permeation (time to breakthrough of agent)/penetration of vapors and liquids			X	X	X		X	X			X	X
	3	Weight change	X	X	X	X	X	X	X	X	X		X	X
	4	Density	X	X	X	X	X				X			X
	5	Off gassing (vapor)	X	X	X	X	X	X	X	X	X		X	X
	6	Contact hazard (liquid)	X	X	X	X	X	X	X	X	X		X	X
Mechanical Properties	7	Elastic modules	X	X	X				X	X	X			
	8	Tensile Properties (yield strength, ductility)	X	X	X		X	X	X	X	X		X	X
	9	Hydrogen embrittlement	X	X	X	X								
	10	Ultimate strength for tension (flexural)		X	X									
	11	Compressive strength	X	X	X			X		X	X			X
	12	Shear strength	X	X	X		X			X	X			X
	13	Fracture toughness (compression, bending, tensile, shear, impact)	X	X	X	X	X	X	X	X	X			X
	14	Hardness (indentation, durometer, scratch resistance)	X	X	X	X	X	X	X	X	X		X	X
	15	Resilience (capacity to absorb energy elastically)	X	X					X	X	X			X
	16	Fatigue strength (includes adhesives for structural bonds)	X	X	X					X	X			X
Mechanical Properties	17	Puncture resistance							X	X	X		X	X
	18	Creep (rupture) strength	X	X	X					X	X			
	19	Compressive spring constant							X		X			
	20	Bond strength	X	X	X						X			X

APPENDIX C. MATERIAL PROPERTIES MATRIX.

TABLE C-1. CONT'D

Properties			Metals	Laminates	Adhesives/Sealants/ Joints (Including Welds)	Coatings	Potting Compounds	Optical Materials (Metal Oxides, Plastics, etc.)	Elastomers	Plastics	Composite Materials	Petroleum, Oil, and Lubricants (POL)	Textiles	Ceramics
POL Properties	21	Thermal stability										X		
	22	Chemical compatibility										X		
	23	Lubricity										X		
	24	Solubility										X		
	25	Melting point/boiling point										X		
	26	Viscosity										X		
Physical Properties	27	Dimensional change	X	X	X	X	X	X	X	X	X		X	X
	28	Color change (discoloration, surface finish)	X	X	X	X	X	X	X	X	X		X	X
	29	Optical clarity/distortion (haze, transmittance, reflectance)				X		X		X				X
	30	Crazing, stress, corrosion, cracking	X	X	X	X	X	X		X				X
	31	Acoustic dampening		X		X					X			
	32	Glass transition temperature		X	X			X	X	X	X			X
	33	Rubber property-effects of liquids							X					
	34	Peel/lap shear strength change		X	X	X					X			
	35	Adhesion (loss of), blistering, spalling		X	X	X	X				X			X
	36	Corrosion rate	X	X	X						X			X
Thermal Properties	37	Thermal conductivity	X	X	X	X	X			X	X			X
	38	Flame resistance		X	X			X	X	X	X		X	X
	39	Flash point/ignition temperature			X	X						X	X	
Electrical Properties	40	Insulative properties (including dissipation factor)		X		X	X		X	X	X			X
	41	Dielectric constant		X	X	X	X	X	X	X	X			X
	42	Electrical conductivity	X	X	X	X	X		X	X	X			
	43	Impedance	X	X	X	X	X		X	X	X			
	44	Relative permittivity		X		X				X	X			X
	45	Polarizability (effect on radar signals)		X		X				X	X			X

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APPENDIX D. ABBREVIATIONS.

ABO	agent of biological origin
AD No.	accession number
APG	Aberdeen Proving Ground
AR	Army Regulation
ASTM	American Society for Testing and Materials
AT&L	acquisition, technology, and logistics
ATEC	U.S. Army Test and Evaluation Command
ATP	Allied Technical Publication
C	Celsius
CARC	Chemical agent-resistant coating
CB	chemical and biological
CBCS	chemical and biological contamination survivability
CBME	chemical and biological materials effects (database)
CBR	chemical, biological, and radiological
CBRCS	CBR contamination survivability
CBRCSA	CBR contamination survivability assessment
CBRN	chemical, biological, radiological, and nuclear
CBRNCS	CBRN contamination survivability
CBRNIAC	CBRN Information Analysis Center
C/D	contamination/decontamination
CDD	capability development document
CFU	colony forming unit
cm	centimeter
COE	concept of employment
CONOPS	concept of operations
CPD	capability production document
CS	contamination survivability
cSt	centistokes
DA	Department of the Army
DOD	Department of Defense
DODI	Department of Defense Instruction
DOTMLPF	doctrine, organization, training, materiel, leadership and education, personnel and facilities
DTIC	Defense Technical Information Center
ECBC	U.S. Army Edgewood Chemical Biological Center
EMP	electromagnetic pulse

APPENDIX D. ABBREVIATIONS.

FD/SC	failure definition/scoring criteria
FM	Field Manual
FP	fluorescent particle
FY	fiscal year
g/L	gGrams per liter
GAO	Government Accountability Office
GBq	gigabecquerel
GC	gas chromatography
GD	soman (CAS number 96-64-0)
HD	distilled mustard (CAS no. 69020-37-7)
HPLC	high-performance liquid chromatography
HSW	hot soapy water
HTH	high-test hypochlorite
IAW	in accordance with
ICAM	Improved Chemical Agent Monitor
ICD	initial capability document
ISO	International Organization for Standardization
kg	kilogram
LC	liquid chromatography
m	meter
m/s	meters per second
ME	mission essential
MIL-STD	Military Standard
mm	millimeter
MMD	mass median diameter
MS	mass spectrometer
NATO	North Atlantic Treaty Organization
NBC	nuclear, biological, and chemical
NBCCS	nuclear, biological, chemical contamination survivability
NDAA	National Defense Authorization Act
NIGA	neutron-induced gamma activity
NRT	near real time
NTA	non-traditional agent

APPENDIX D. ABBREVIATIONS.

OEP	OTA evaluation plan
OMB	Office of Management and Budget
OTA	operational test agency
PAM	pamphlet
POL	petroleum, oil, and lubricants
PM	program manager
psi	pounds per square inch
QA	quality assurance
QC	quality control
QSTAG	Quadripartite Standardization Agreement
RAR	Rapid Action Revision
RDD	radiological dispersal device
RH	relative humidity
SOMTE	Soldier, operator, maintainer, tester and evaluator
SOP	standing operating procedure
SST	solid sorbent tube
STB	Supertropical bleach
SUT	system under test
TEMP	test and evaluation master plan
TGD	thickened soman
TIC	toxic industrial chemical
TIM	toxic industrial material
TOP	Test Operations Procedure
U.S.	United States
USANCA	U.S. Army Nuclear and Combating Weapons of Mass Destruction Agency
USD(AT&L)	Under Secretary of Defense for Acquisition, Technology and Logistics
VX	persistent nerve agent (CAS number 70938-84-0)

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APPENDIX F. APPROVAL AUTHORITY.

CSTE-TM 3 August 2016

MEMORANDUM FOR

Commanders, All Test Centers
Technical Directors, All Test Centers
Directors, U.S. Army Evaluation Center
Commander, U.S. Army Operational Test Command

SUBJECT: Test Operations Procedure (TOP) 08-2-509A Chemical, Biological, and Radiological (CBR) Contamination Survivability, Large Item Interiors, Approved for Publication

1. TOP 08-2-509A Chemical, Biological, and Radiological (CBR) Contamination Survivability, Large Item Interiors, has been reviewed by the U.S. Army Test and Evaluation Command (ATEC) Test Centers, the U.S. Army Operational Test Command, and the U.S. Army Evaluation Center. All comments received during the formal coordination period have been adjudicated by the preparing agency. The scope of the document is as follows:

This TOP provides basic information to facilitate planning, conducting, and reporting of large item interiors testing such as tactical vehicles, fixed and rotor wing tactical aircraft, vans, shelters, building interiors, shipboard interiors, and cargo aircraft interiors. It is designed to provide results to determine if large items of mission-essential equipment have met applicable chemical, biological, and radiological contamination survivability requirements.

2. This document is approved for publication and will be posted to the Reference Library of the ATEC Vision Digital Library System (VDLS). The VDLS website can be accessed at https://vdls.atc.army.mil/.

3. Comments, suggestions, or questions on this document should be addressed to U.S. Army Test and Evaluation Command (CSTE-TM), 2202 Aberdeen Boulevard-Third Floor, Aberdeen Proving Ground, MD 21005-5001; or e-mailed to usarmy.apg.atec.mbx.atec-standards@mail.mil.

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Forward comments, recommended changes, or any pertinent data which may be of use in improving this publication to the following address: Range Infrastructure Division (CSTE-TM), U.S. Army Test and Evaluation Command, 2202 Aberdeen Boulevard, Aberdeen Proving Ground, Maryland 21005-5001. Technical information may be obtained from the preparing activity: Commander, U.S. Army Dugway Proving Ground (TEDT-DPW), Dugway, Utah 84022-5000. Additional copies can be requested through the following website: http://www.atec.army.mil/publications/topsindex.aspx, or through the Defense Technical Information Center, 8725 John J. Kingman Rd., STE 0944, Fort Belvoir, VA 22060-6218. This document is identified by the accession number (AD No.) printed on the first page.